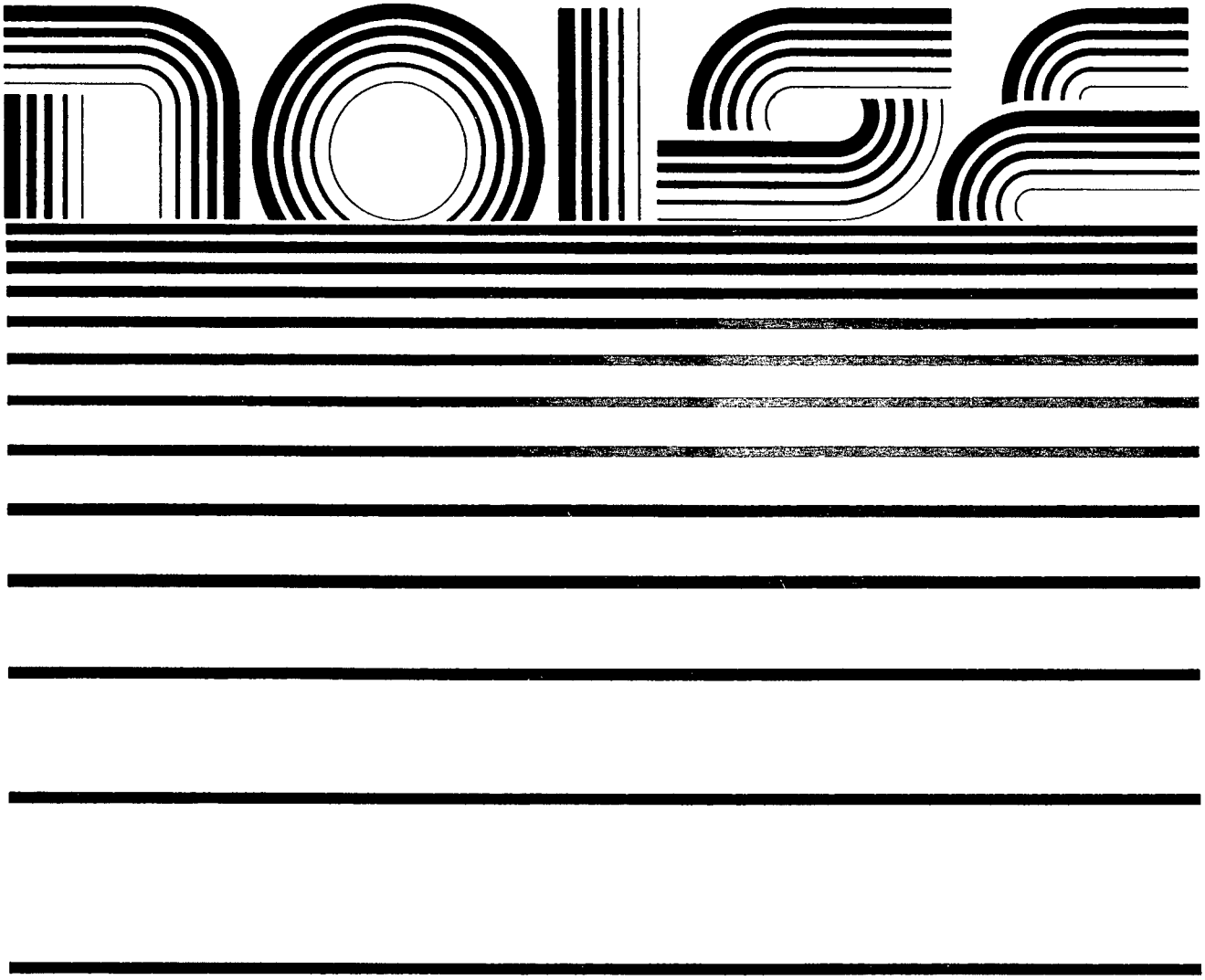
HIGHWAY



A Guide to Visual Quality in Noise Barrier Design

Implementation Package 77-12
U.S. Department of Transportation
Federal Highway Administration

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Randolph F. Blum
December 1976

Prepared by
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Prepared for
The U.S. Department of Transportation
Federal Highway Administration
Washington, D.C. 20590

Table of Contents

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Chapter 1

Introduction

Introduction

Highway Noise Abatement

Introduction

This publication is designed as a guide to aid individuals entrusted with the design of highway noise barriers, particularly in regard to visual quality. This guide introduces the basic principles of visual quality in general terms and illustrates the application of these basic principles to the design of highway noise barriers.

Design is a Process. The design of highway noise barriers is a process which involves a logical sequence of events including inventory, analysis, concept development, preliminary design, structural and detail design, etc. This guide indicates how visual design principles can be incorporated into this process.

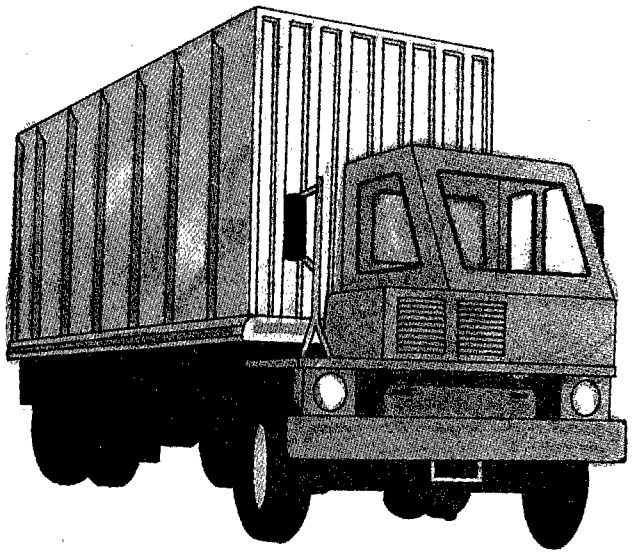
Highway noise abatement measures can create visual problems due to the nature of the noise barrier and its acoustical requirements. This guide illustrates the potential visual problems created by noise barriers and identifies design measures which will minimize the visual disruption of the environment due to the construction of noise barriers.

Highway Noise Abatement

Noise is defined as any undesirable, unwanted sound. Highway noise is unwanted sound originating from motor vehicles—engine, cooling fan, exhaust system, and tires contribute primarily to the din heard along any heavily travelled highway.

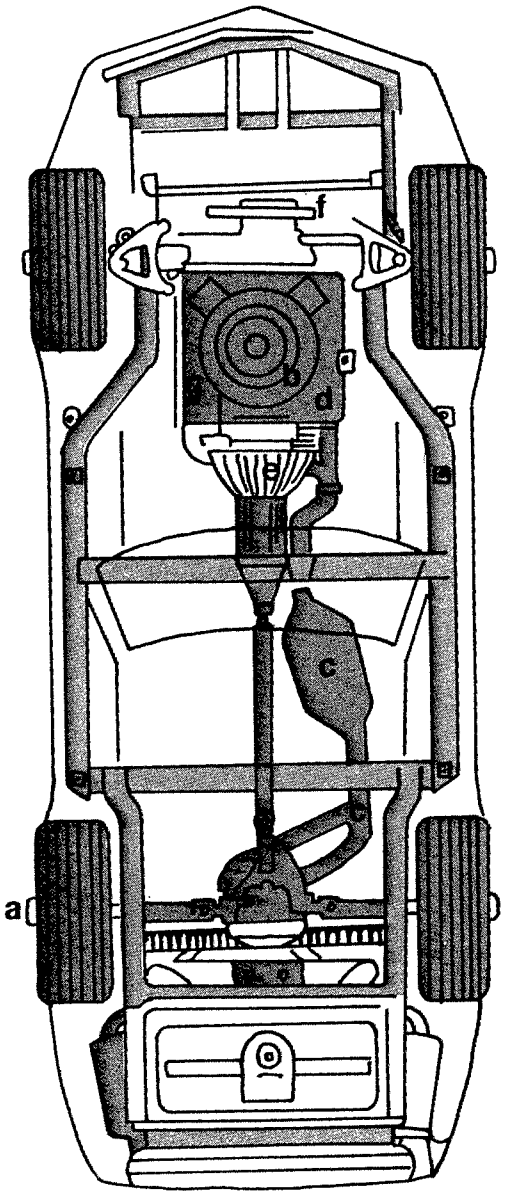
Noise abatement is any positive measure undertaken to reduce the undesirable noise emanating from a *source* or to reduce the noise level at a *receiver*—in this case a person likely to be sensitive to excessive noise. In highway noise abatement, the *path* between source and receiver is blocked by the installation of a *noise barrier* which reduces the amount of noise reaching the receiver. To be acoustically effective, a noise barrier must interrupt the *line-of-sight* between source and receiver. Furthermore, research has shown that a barrier must be placed as close as possible to the source to achieve maximum noise reduction. Barrier effectiveness is increased if the barrier is *acoustically opaque;* therefore, solid objects without visible openings are required. The acoustical requirements for highway noise barriers create potential visual problems because blocking the line-of-sight means blocking the view. Placing the barrier close to the source (vehicles), means that noise barriers will be highly visible from the roadway. This guide will discuss the visual problems created by noise barriers and will examine the visual quality of various types of barriers currently in use throughout the United States.

Noise barriers currently in use in the United States consist of three distinct types: *earth berms, walls,* and combinations of *berms* and *walls.* Earth berms are mounds or embankments of earth created along a highway to block the line-of-sight between the highway and noise sensitive areas such as residential housing, schools, hospitals, etc. The mass of the berm effectively attenuates the transmission of sound. Similarly, solid walls placed along a highway reduce the noise level on the receiver side of the wall. Walls are perhaps the most common method of highway noise abatement and have been constructed from a variety of materials. Combination berms and walls are berms upon which a wall is placed in order to achieve the desired height.



Often these are constructed where space limitations prevent construction of a berm alone. Research into the theory and practice of highway noise abatement is a continuing effort throughout the world, and additional methods may become available in the future. This publication is concerned with visual design in relation to the current state-of-the-art of highway noise abatement.

This manual is a guide to the basic principles which affect visual perception. These principles should serve as tools for the designer of highway noise barriers. It is not the purpose of this publication to provide design solutions to noise abatement, but rather it is to illustrate and emphasize the need for visual quality as part of the design process. As such, the manual should be used as a supplement to technical information concerning noise abatement in an effort to produce highway noise barriers which are functional, attractive, and visually related to the surrounding environment.

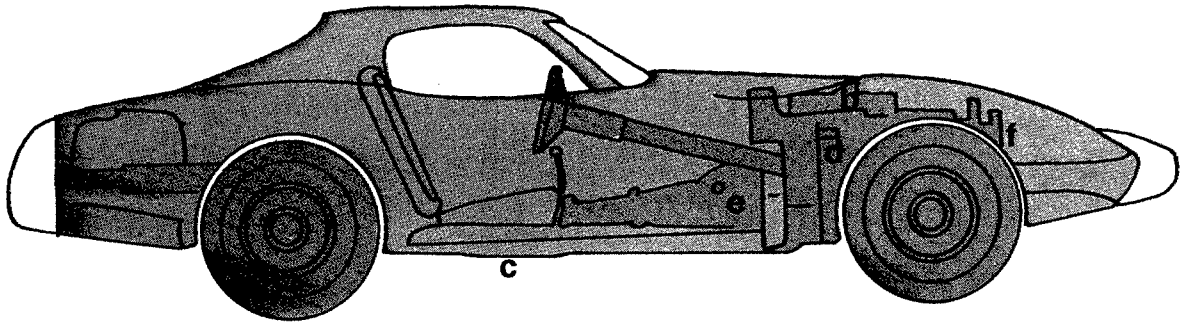


Plan View

Example of Major Noise Sources in a Car

a. Tire Noise
b. Primary Inlet and Exhaust Noise
c. Noise Radiated by Walls of Inlet and Exhaust Systems
d. Engine Vibration Emitted Noise
e. Gear Box and Transmission Noise
f. Cooling Fan Noise

(Source: Alexandre, A., **Road Traffic Noise**)



Elevation View

Chapter 2

Aesthetics in the Design Process

The Problem

The Design Process

A Planning Approach

Landscape Inventory

Citizen Participation

Analysis

Development of Concepts

Preliminary Design

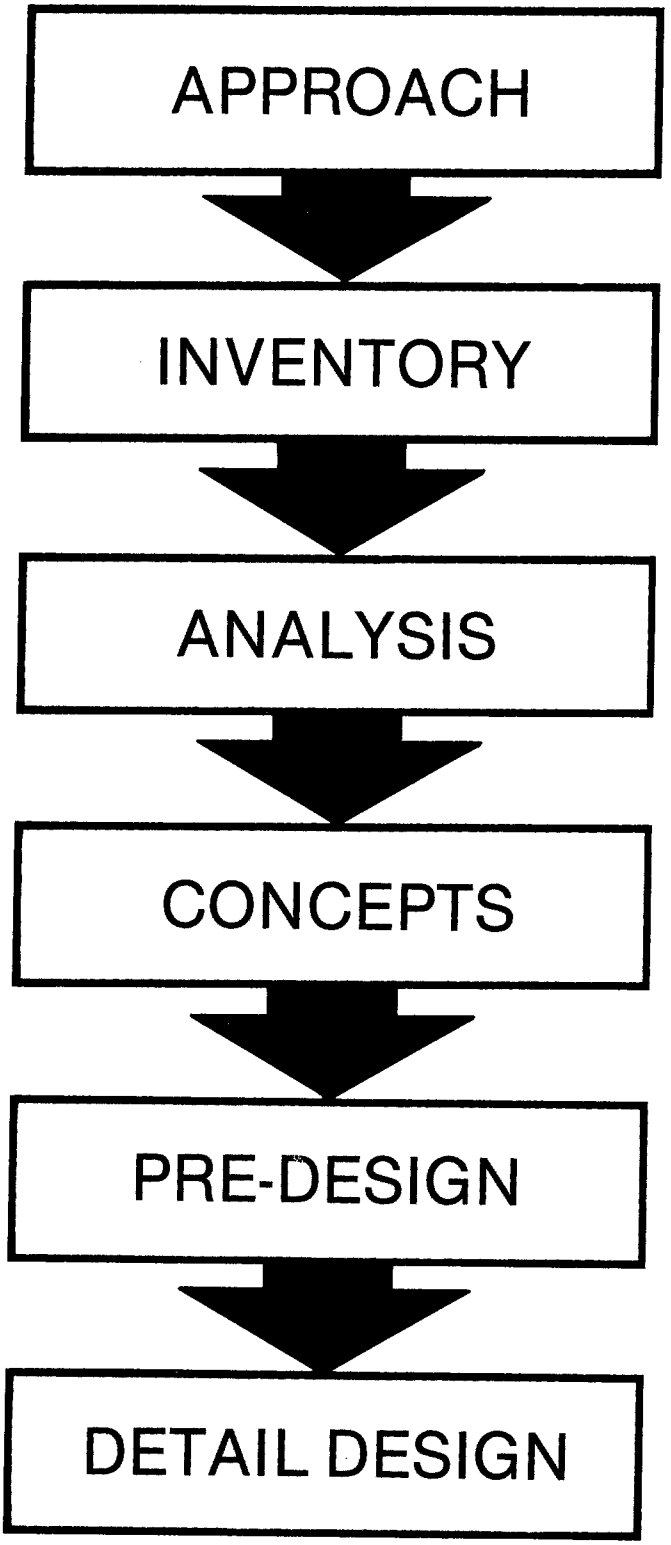
Detailed Design

The Problem

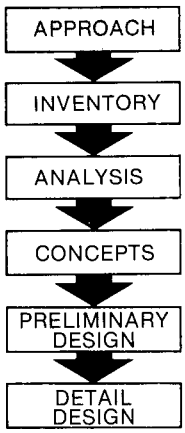
A successful design is one which achieves the goals for which it was conceived. These goals may vary even for similar design problems. When noise along a highway is excessive, abatement of the noise becomes a design goal. A number of highway noise barriers exist today. They are primarily free-standing walls constructed of a variety of materials. Very few of these walls can be considered a visually successful complement to the community. Most of the noise barriers along highways are an intrusion into the environment, blending neither with the highway nor with the surrounding neighborhood for which they were built.

Many of the barriers are attractive and have been designed with great care and attention to detail. However, more often than not, these barriers do not relate to other elements in the surrounding environment. They appear to be standardized designs plugged in where needed to abate noise without regard for the impact of the barrier on the overall visual environment. Often a well proportioned, basic design is stretched, squeezed, elongated, compressed, heightened and shortened in order to fit into the necessary space and to achieve the desired height for noise abatement. When placed in the landscape and viewed as part of the total environment, a barrier such as this seems out of place, visually oppressive, and overly dominant. Somewhere in the design process, the visual significance of noise barriers in the landscape was not given adequate consideration.

The Design Process



APPROACH

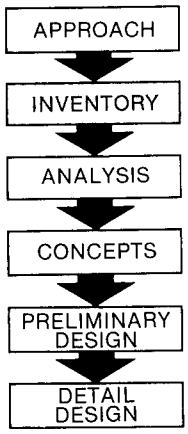


1. ARCHITECT / PLANNER
2. LANDSCAPE ARCHITECT
3. HIGHWAY ENGINEER
4. ACOUSTICAL ENGINEER
5. STRUCTURAL ENGINEER

A Planning Approach

In order to achieve a successful noise barrier design, many important aspects must be considered. The noise barrier must be acoustically effective, structurally sound, safe for the motorist, durable, and visually attractive. Most highway departments employ representatives from a variety of professions who are highly trained in their particular area of expertise. A successful noise abatement system can be achieved through the use of an *inter-disciplinary planning approach* in which a team of professionals coordinate in an effort to achieve the design goals. Highway engineers, structural engineers, acoustical engineers, architects, and landscape architects all need to provide input from their own area of professional training. An architect and landscape architect should provide design assistance throughout the planning process, not as a last minute cosmetic treatment. At this point, it is probably too late to achieve a visually attractive design which is related to the site and the surrounding environment. A noise barrier should become a complement to the community, not an eyesore.

INVENTORY



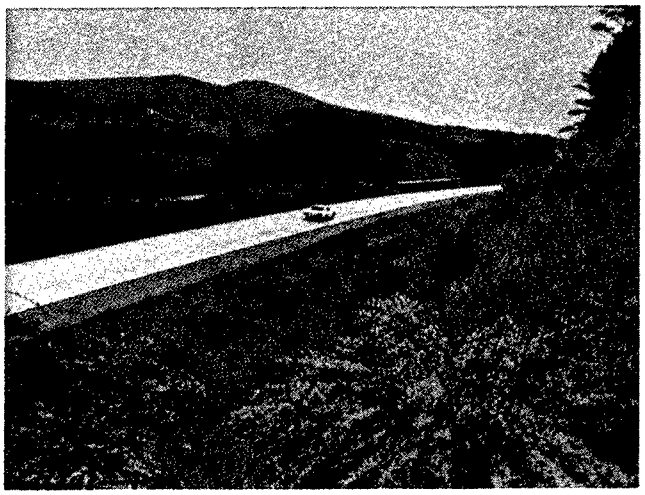
1. ARCHITECT / PLANNER
   - Existing Community Development
   - Existing Architectural Characteristics
2. LANDSCAPE ARCHITECT
   - Existing Landscape & Environmental Features
3. CITIZENS
   - Preferences
4. HIGHWAY ENGINEER
   - Existing Traffic Volumes
   - Projected Traffic Volumes
   - Percentage of Trucks
   - Regional Transportation Planning Objectives

Landscape Inventory as a Design Tool

An important step in the design process is the inventory, a visual analysis of the proposed site and the relationships that exist between the components of the neighborhood, community and geographical area for which the design is intended. Following construction, the proposed design will become a part of that neighborhood or community, just as houses, schools, trees, rivers, etc., combine to become a unique entity. Each community or neighborhood has a distinct *character.* A site inventory should include a determination of the character of the neighborhood. The primary determination should be the level of existing development. The site and surroundings should be classified into *rural, urban* and *suburban.* Each classification has unique environmental and social characteristics which should become the criteria for visual design.

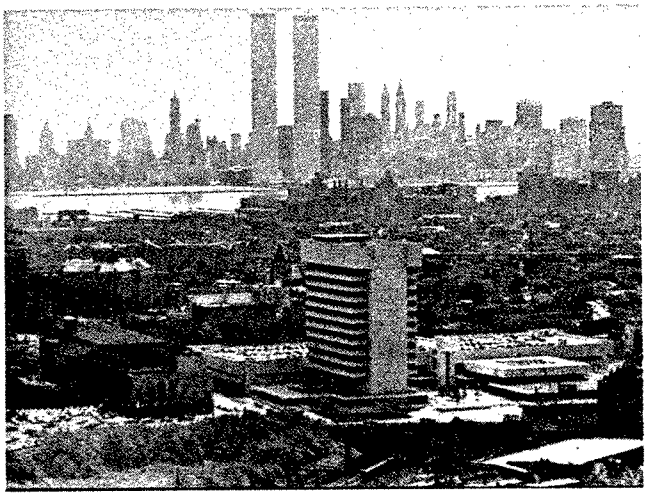
The character of a *rural* environment is one of open spaces, native trees and shrubs, rustic fences, earth, and sky. There is little orderly development. The materials associated with this type of environment are weathered wood, rock, earth, and trees. A marble plaza with fountains and waterfalls obviously would be out of character in this type of environment. Likewise, a noise barrier constructed of materials not associated with the rural atmosphere would be out of character.

Landscape character: rural

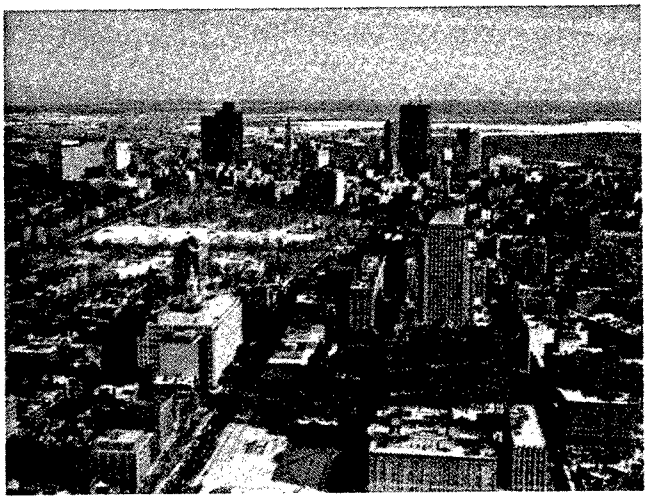


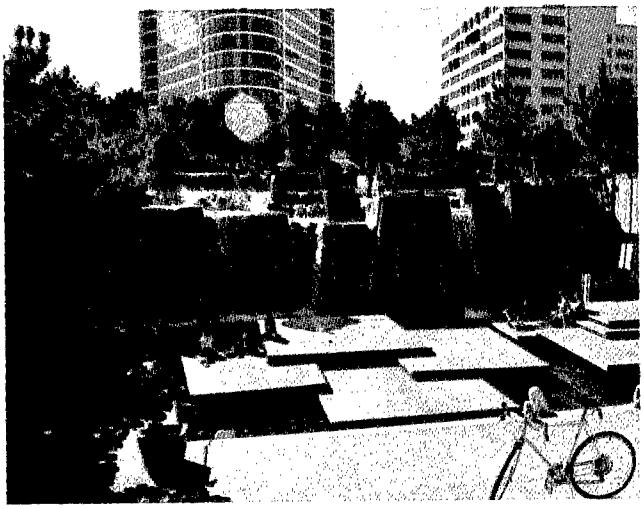
Materials associated with the rural environment

The character of the *urban* environment is one of refined development, activity, orderly and often confined spaces, pavement, and structure. Materials present in this environment are concrete, brick, steel, and consciously placed trees and shrubs. An earth mound with tall grass and wild flowers would seem unkempt and out of place here. Therefore, the urban character of this environment should be reflected in the type of noise barrier placed here, and in the choice of materials from which it is constructed.

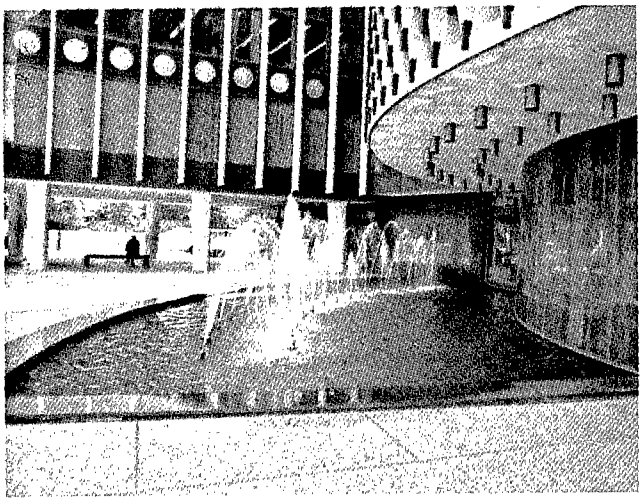


Landscape character: urban

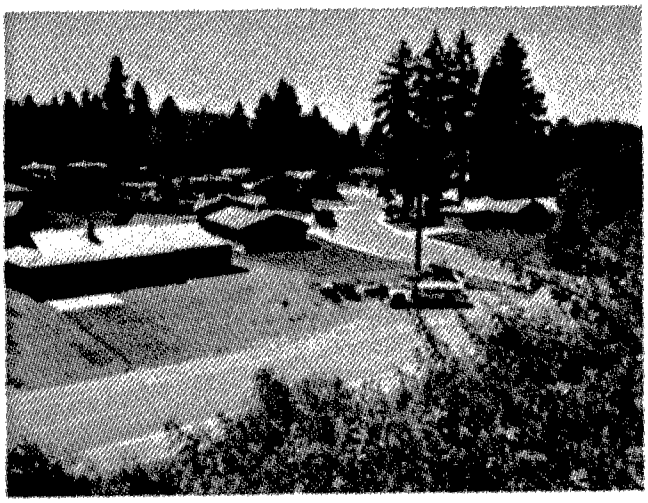




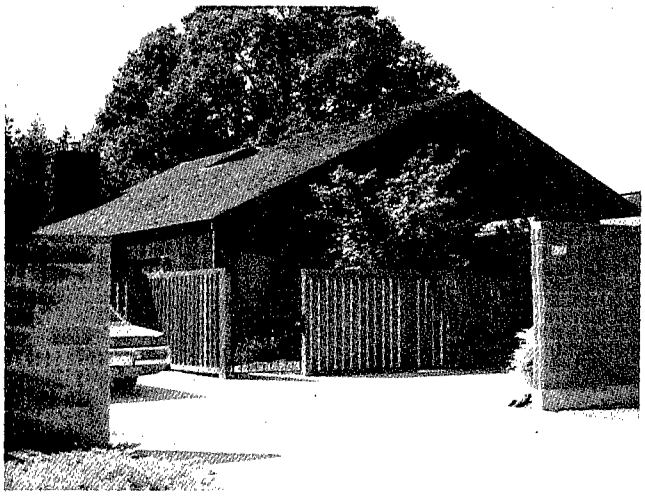
Materials associated with an urban environment



Suburban environments contain the characteristics of both rural and urban situations and are most often the environments into which a noise barrier is placed. Regardless of the type of environment, the unique characteristics of each site and its surroundings should be studied as an aid to visual design. A determination should be made as to the predominant architectural styles and building materials used in the area. Similarity of materials or methods of construction are often significant features which identify a neighborhood and give it a unique character. These similarities should be expressed in a noise barrier to achieve a visual relationship between community and barrier.



A typical suburban environment



Typical materials found in a suburban environment

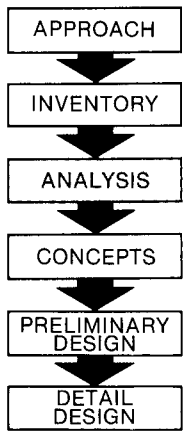
Natural features in an area combine with manmade structures to give that area its character. Important natural elements include topographical features: hills, valleys, plains, mountains, etc. Other natural elements include rivers, streams, lakes, oceans, ponds, and a variety of vegetation types such as trees, shrubs, grassland or a combination of these. These are presented to the observer by a view; perception of both manmade and natural elements in their respective locations determines the view and the character of the area being observed. Careful consideration of the components of the view is important to the designer who intends to place an object within that view. Designs that visually fit in with their environment reflect the character of their surroundings in one way or another. It is necessary to consider these components of the visual environment, along with other site information, such as building heights, elevation differences, circulation routes, etc., when assembling base information prior to design.

Citizen Participation

The primary objective in noise abatement is adequate noise protection for the public. Citizens motivate action for noise abatement through both formal and informal complaints. Reactions to a noise abatement system often comes after the system is constructed. Frequently, the reactions to noise barriers after construction are negative. Most complaints focus on either the visual appearance of the barrier or a change in scenic view. Citizen response to noise barriers is justified—*although the barrier is built for their benefit, it also becomes a part of their environment.* A motorist views a barrier from a distance, usually at a high rate of speed. Even a substantial barrier a mile long is seen by a motorist for only a few minutes. It becomes a small part of his or her total driving experience. A resident living adjacent to a barrier, however, views that barrier on a daily basis. Therefore, it is the citizen's right to express a reaction to the barrier since it may be an intrusion into their daily life. Experience has shown that citizen participation in the design process results in fewer complaints following construction of noise barriers.

Citizens likely to be affected by the construction of a noise barrier should be advised of the decision-making, design, and construction processes, including objectives, constraints, and all possible solutions. Public meetings are one of the most effective methods for educating the public about general noise abatement principles, the variety of abatement methods available, and the beneficial and adverse effects of the various alternatives. Individual owners should be divided into groups representing ownership of land in one particular geographical area. In this way, the preferences of a majority of landowners in an area can be determined at one time. Public meetings and neighborhood workshops are the best tools for accomplishing this objective.

Several states have offered citizens a choice of barrier types, materials, and colors. Some states have offered a choice of either a noise barrier or increased landscaping along a section of highway. In several cases, citizens have decided against construction of a noise barrier. They preferred increased plantings of trees and shrubs even though they were advised that this would not significantly decrease the noise. Since most objections to noise barriers relate to loss of scenic view or the visual appearance of completed barriers, the desires of residents must be satisfied. A barrier is more likely to be accepted by the public if it is a visual complement to the community.



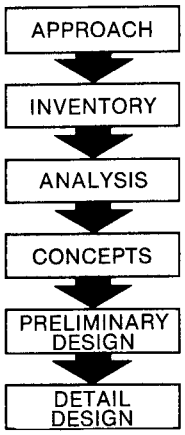
ANALYSIS

1. ARCHITECT / PLANNER
   Design Continuity
   Design Configurations
2. LANDSCAPE ARCHITECT
   Environmental Esthetic Needs
   Functional Space Planning Needs
3. HIGHWAY ENGINEER
   Safety & Visibility Standards
4. ACOUSTICAL ENGINEER
   Noise Reduction Requirements

Analysis

The team approach can be used to analyze and evaluate information obtained throughout the inventory stage of the design process. The objective is to identify planning, design, and environmental needs for the highway and the community in relation to the proposed noise abatement project. Potential continuity between existing and proposed site structures should be identified and discussed. Noise control alternatives should be prepared and discussed. Visual suitability of barrier types for the proposed site should be determined. Trade-offs between engineers, architects and landscape architects are necessary to ensure that the end product is the best practical and aesthetically pleasing solution based on the design standards of each profession.

CONCEPTS



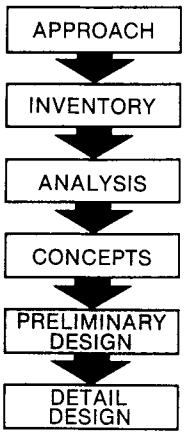
1. ARCHITECT / PLANNER
   Form, Visual and
   Community Relationships
2. LANDSCAPE ARCHITECT
   Site, Environmental, Visual
   Relationships
3. HIGHWAY ENGINEER
   Highway Relationships
   Circulation Continuity
4. ACOUSTICAL ENGINEER
   Noise Reduction Theories
   Application of Principles

Development of Concepts

Concepts are abstract ideas that develop from the inventory and analysis of existing conditions, future needs and constraints imposed by the site, the function of the highway, and adjacent human activities. These ideas set the framework for selection of design schemes, locations for structures and detailed design.

Each member of the inter-disciplinary design team should be involved in concept development to ensure that the principles of each profession are expressed in the end product, a functional and attractive noise barrier.

PRE-DESIGN

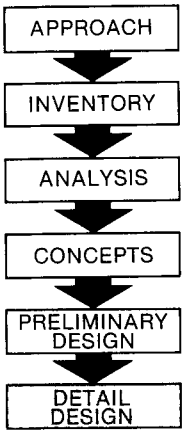


1. ARCHITECT / PLANNER
   Visual, Design
   Configuration Materials
2. LANDSCAPE ARCHITECT
   Visual, Environmental
   Materials Functional
   Planning
3. HIGHWAY ENGINEER
   Safety, Sigh Distance
   Maintenance
4. ACOUSTICAL ENGINEER
   Noise Reduction Materials
   Heights, Lengths,
   Thickness Requirements

Preliminary Design

Development of an appropriate preliminary design should follow evaluation and concept development and should use requirements and principles developed during those phases. These should serve as a base; the design principles of each profession should be applied to this base. The design should reflect consideration of basic site requirements, visual requirements, and interdisciplinary design criteria. Design configurations, barrier locations, materials, and other design decisions should be made at this time.

DETAIL DESIGN



1. ARCHITECT / PLANNER
   Details of Form, Texture and Color
2. LANDSCAPE ARCHITECT
   Details of Grading, Planting
3. HIGHWAY ENGINEER
   Details of Grading, Drainage and Right of Way Requirements
4. ACOUSTICAL ENGINEER
   Details of Acoustical Design
5. STRUCTURAL ENGINEER
   Details Construction Requirements

Detailed Design

Detailed design transfers design ideas into reality. In this phase of the project, architects and landscape architects should suggest grading details, textures, colors, plantings, etc., which shall serve to further blend the proposed project into the surrounding environment. A successful noise barrier design requires that visual design principles be utilized to reduce objectionable visual impact. Visual impact is reduced through a conscious coordination between site and structure. Noise barrier designs that result from coordination of interdisciplinary principles should reflect the best possible solution to the problem of highway noise abatement.

Chapter 3

Visual Design Principles

Major Elements

Coordinate Elements

Variable Factors

Visual Design Principles

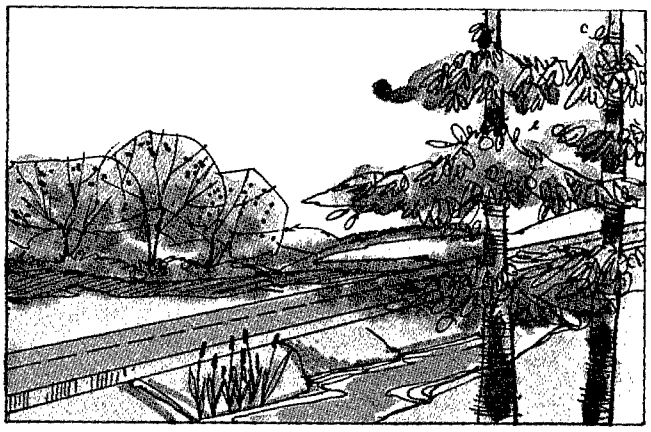
It has been said that 87 percent of our perception is based on sight. What we see is a combination of *masses* and *spaces.* The art of design revolves around the composition of masses and spaces. Space itself is endless, having limits only when interrupted by a mass. There are two types of spaces: *open space* and *enclosed space.* The sensation that accompanies open space is one of exhilaration, the feeling one gets when standing on a mountaintop with an uninterrupted view. Enclosed space imparts a feeling of retreat, or shelter, to one within its boundaries. Enclosure tends to heighten the senses, and one becomes aware of details and movement. Masses are the solid objects one normally associates with design. A skillful designer coordinates the use of mass and space to create a visually pleasant experience for the viewer.

"Open space exists when an open space is large in relation to the height of its boundaries."

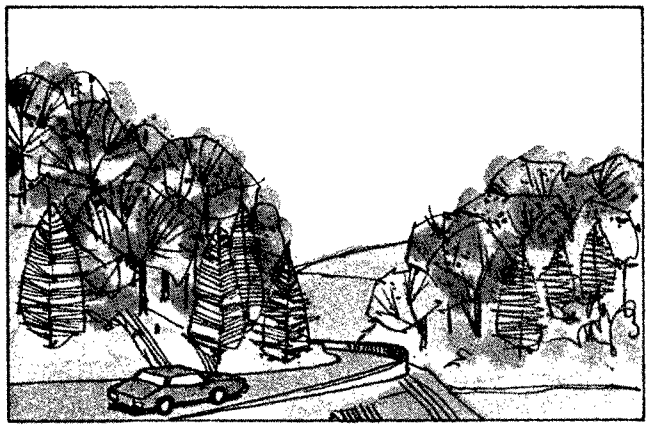
"An enclosed space exists when an open area is small or the boundaries high. . . . We are essentially within its volume."

"We experience masses from outside, spaces from inside. A space is our temporary environment."

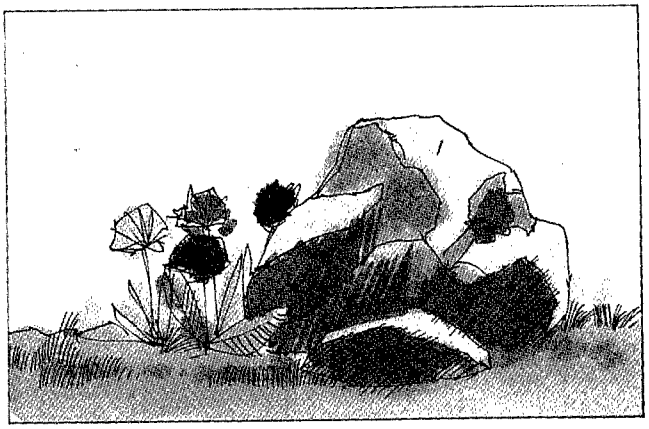
Quotes from . . .
Nan Fairbrother



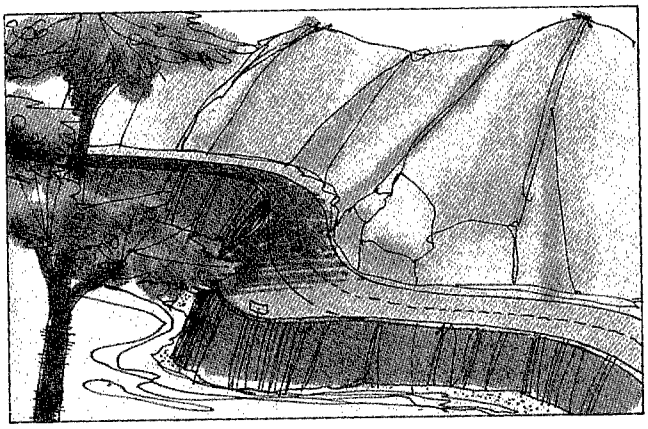
Line



Color



Form



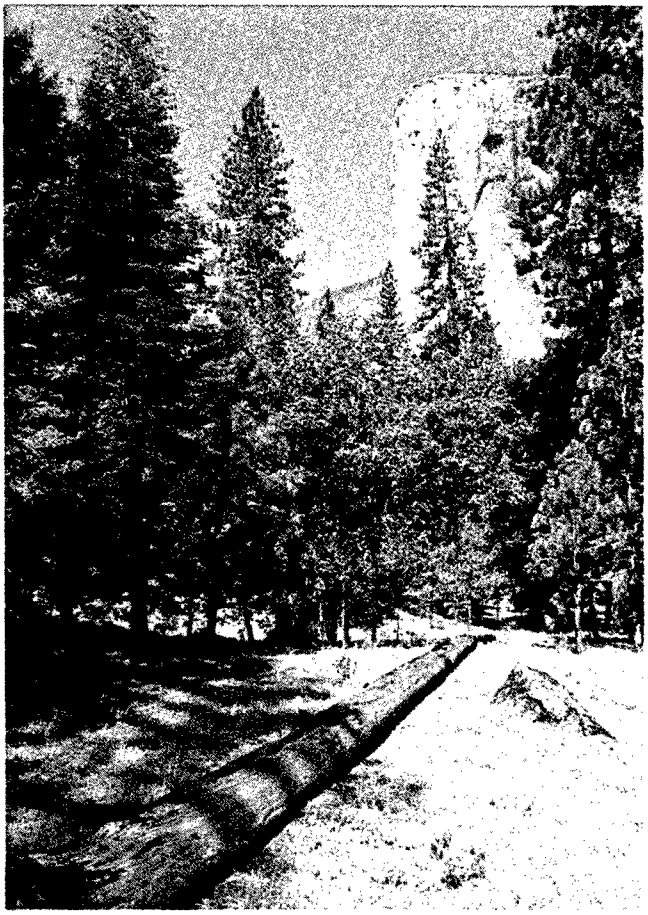
Texture

Visual perception of mass and space consists of four major elements: line, form, color, and texture. The characteristics of each element are identifiable in any visual composition, although one or more elements may dominate the composition.

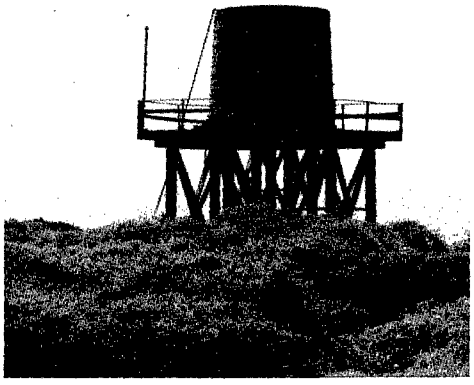
Line is a direct link between two points. Line may be actual or implied, such as an arrangement of two or more objects in a row. Lines exist in nature as silhouettes of objects. Examples are a ridge line of a mountain, the banks of a river, or the trunk of a tree. The horizon is a distinct natural line. Man-made lines on the landscape include roads, fences, bridges, and the outlines of structures. The straight line was developed for convenience and economy in design. Long straight lines rarely occur in nature.

Lines which are long and straight tend to dominate in a natural setting, which consists mainly of short segments of straight lines and curvilinear or free-form lines.

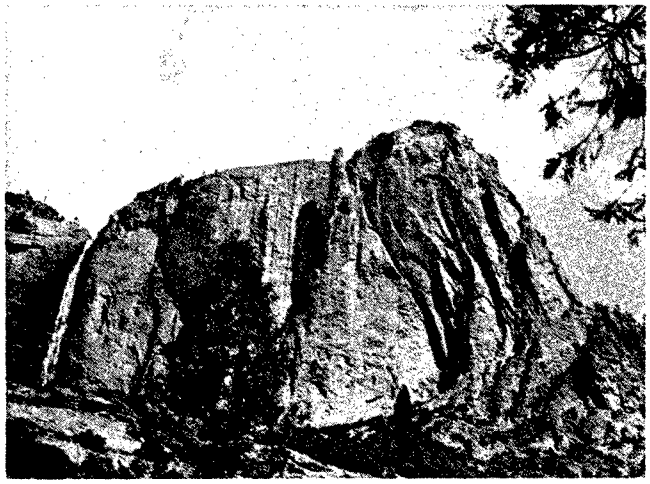
Lines in the environment



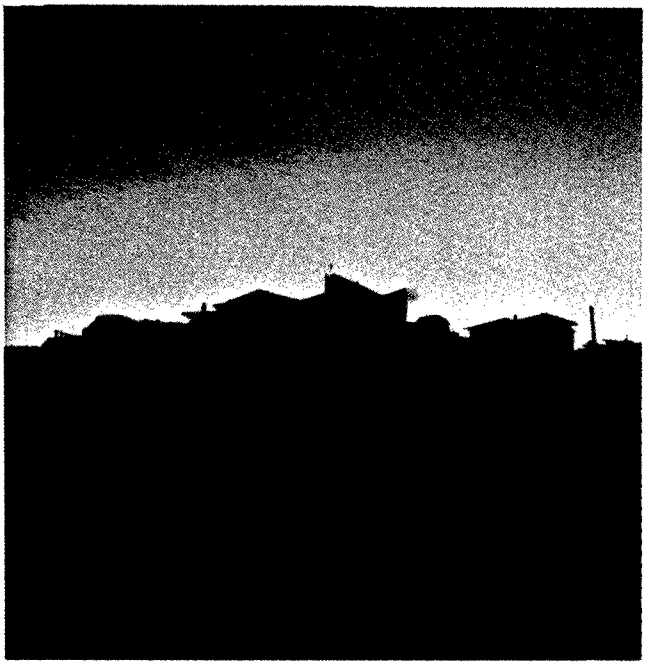
A line in the environment tends to direct the eye.



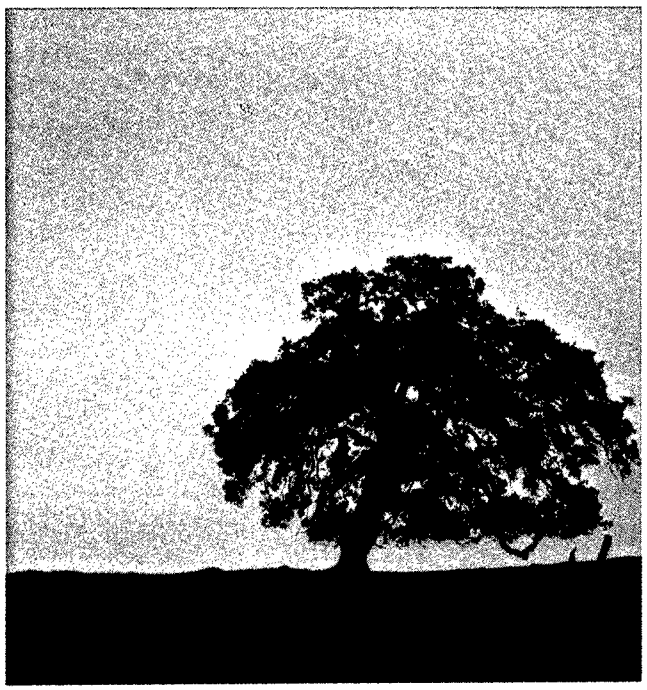
Form is closely related to the term, mass. The bulk that comprises an object, or mass, is arranged in such a way as to create shape, or form. Form exists in nature, as mountains, trees, boulders, pebbles. Man creates form in buildings, cars, structures of any type. Separate objects can create forms when viewed from a distance such as several trees forming a clump or many buildings forming a single cityscape.



Natural form



Manmade form blended with natural form

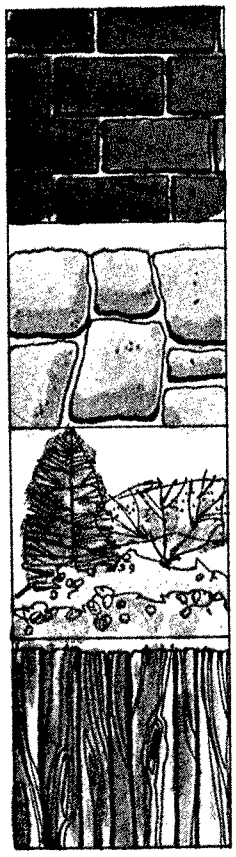


Color

Color is the breakdown of light into distinct visual elements. When an individual sees a color, an optical reaction is recorded in the memory as an aid to identification. Each color has a separate reaction and is recorded as such. Each future experience with a color triggers the same reaction to a common stimulus—identical colors. Color reaction is automatic and intuitive in most humans and occurs without our conscious awareness. As we become educated, we are taught to identify the reaction with a name—red, yellow, blue. Pure white, we are taught, is the absence of color.

Colors that occur most frequently in nature are greens, blues, and browns in varying shades. Man produces and uses a wide range of colors because of the strong sensations they produce. Colors that harmonize well seem to belong together and produce pleasing visual effects. Colors that do not harmonize are disturbing to the viewer. Colors are further broken down into light and dark and into intensity ranges from vivid to dull. Generally, bright vivid color combinations produce startling dramatic effects, and less bright colors tend to produce quiet and restful moods.

EARTH COLORS
found in natural materials

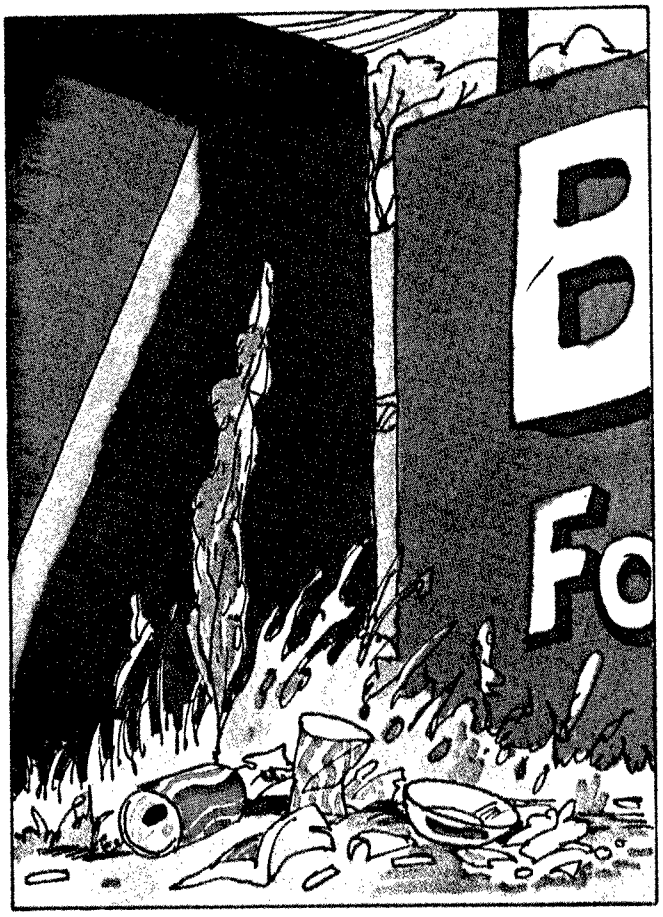


Brick

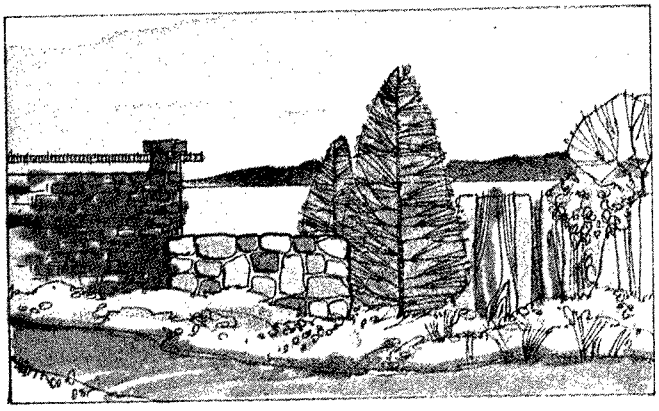
Rock

Foliage

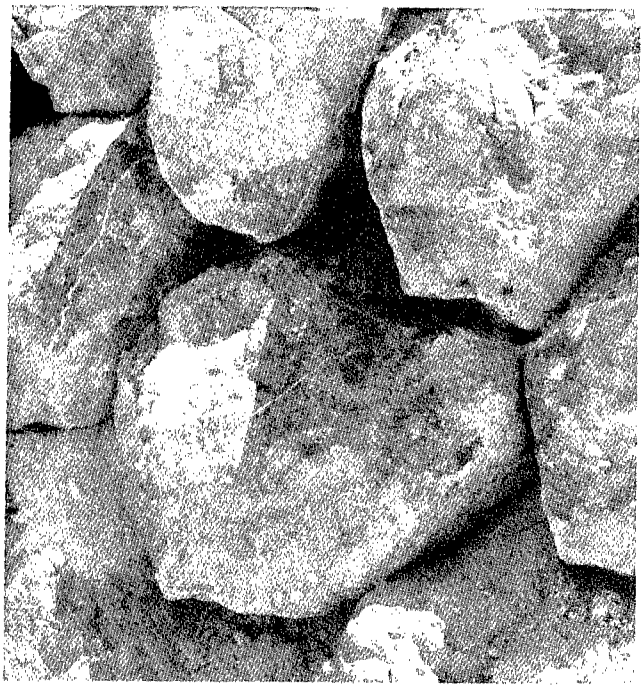
Weathered wood



Non-harmonious colors, often used on billboards to attract attention

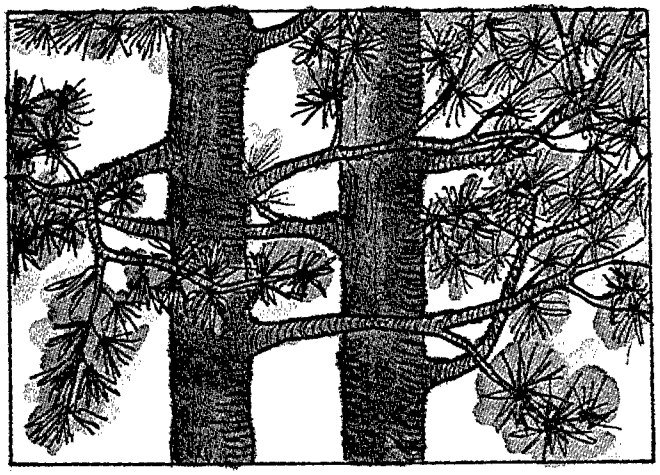


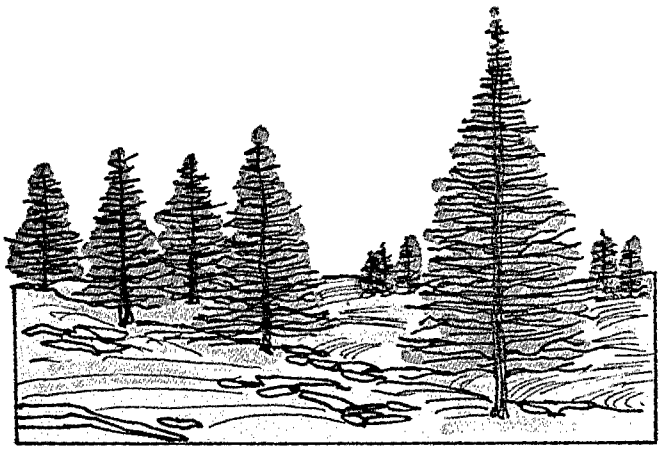
Earth colors harmonize well in the environment



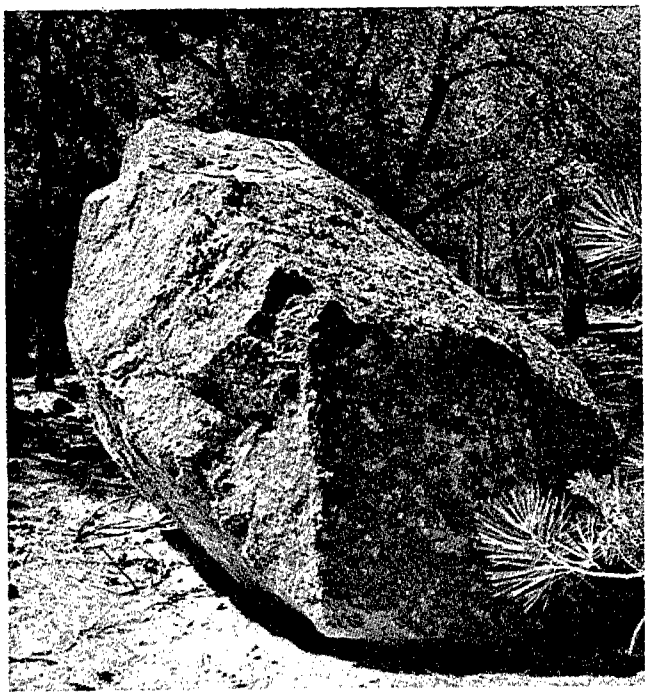
Texture is exhibited on the surface of all objects. It may be described as the relative coarseness of the surface. This varies from a relatively smooth, or fine texture, to a very rough, or coarse texture. A surface with a rough texture varies in depth and is often called a raised surface. A raised surface causes minute shadows to be cast on other parts of the surface which produces an interesting, three-dimensional effect. Skillful use of textural differences in design results in subtle but definitely pleasant visual effects.

Textural differences in nature cover a broad range; therefore, they must be grouped into fine textures, medium textures, and coarse textures. Distance alters our perception of texture; one must view fine textured objects at close range in order to see the texture. When viewed from a distance, fine textured surfaces blend into a single tone and appear flat. Coarse textured objects are distinguishable from greater distances. The infinite variety of textures that we experience in our daily lives is responsible for a great deal of our perception of objects and our visual interest in both natural and manmade features.

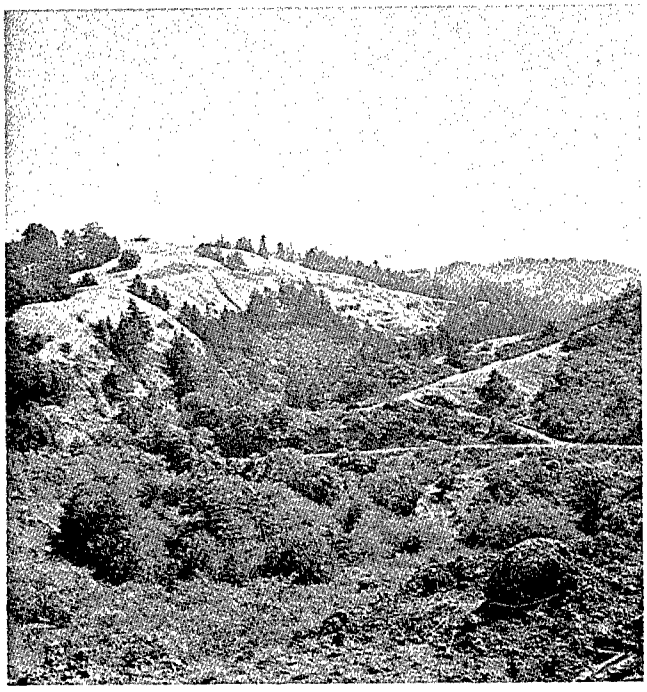




Texture varies with distance



Fine and coarse textures in nature, exhibited by the rock and pine branch



Coarse texture in plant materials

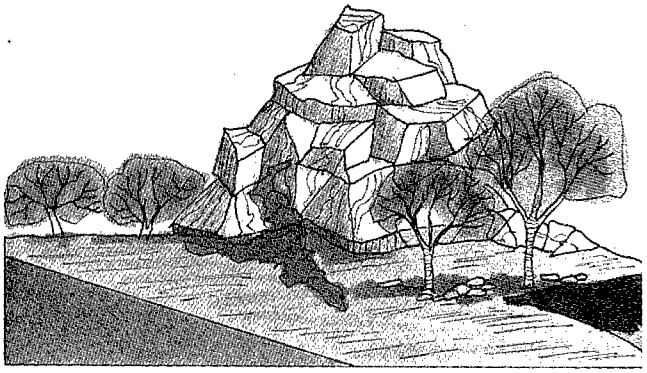
Coordinate Elements

- contrast
- sequence
- axis
- dominance

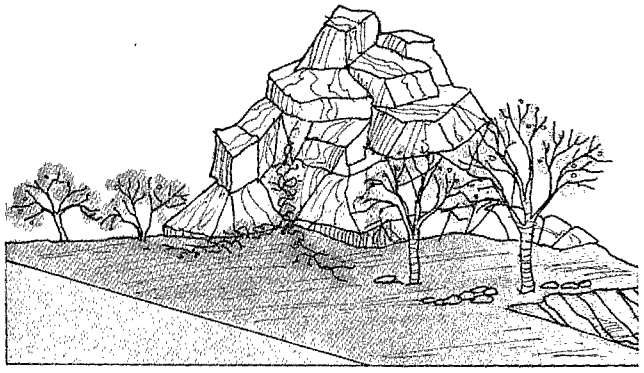
Coordinate Elements

Visual perception of major elements is further controlled by four coordinate elements: contrast, sequence, axis, and dominance. These elements exist singly or in combinations, and produce varying effects on the viewer.

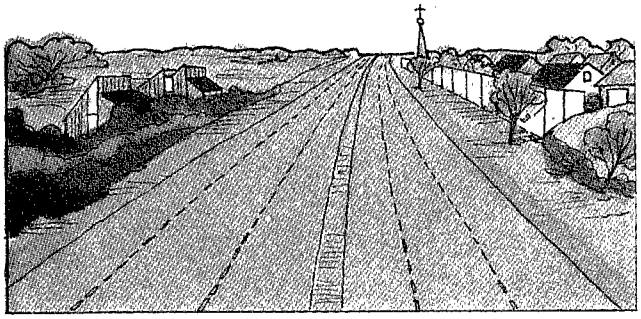
Contrast is a visible difference, usually associated with color. The degree of contrast is the amount of noticeable difference between two or more objects, colors, surfaces or units being compared. Items exhibiting high contrast show a marked difference between each other even when viewed at great distances. Items of low contrast are difficult to distinguish even at close range. The natural environment is generally of low to medium contrast since natural features tend to be similar in color intensity. Manmade objects in the environment are often of high contrast compared to their surroundings. This tends to call attention to the presence of an object. Contrast may be used to advantage by the designer when it is desired to have objects easily seen. For example, road signs and pavement markings employ contrasting colors for safety reasons. High contrast can be detrimental if it causes unnecessary distraction away from a desired view.

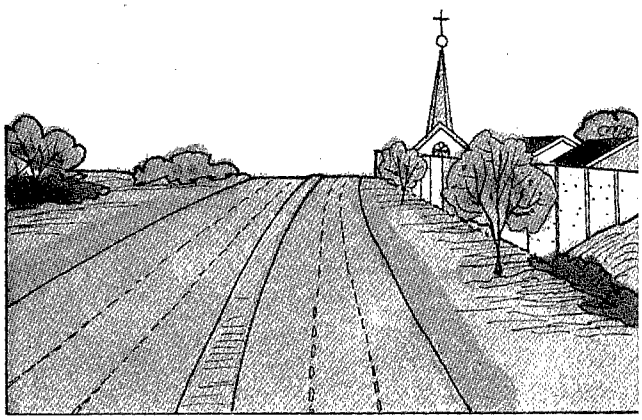


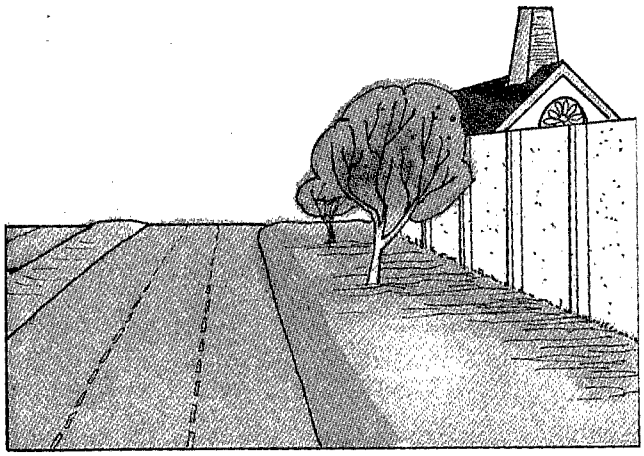
High contrast



Low contrast







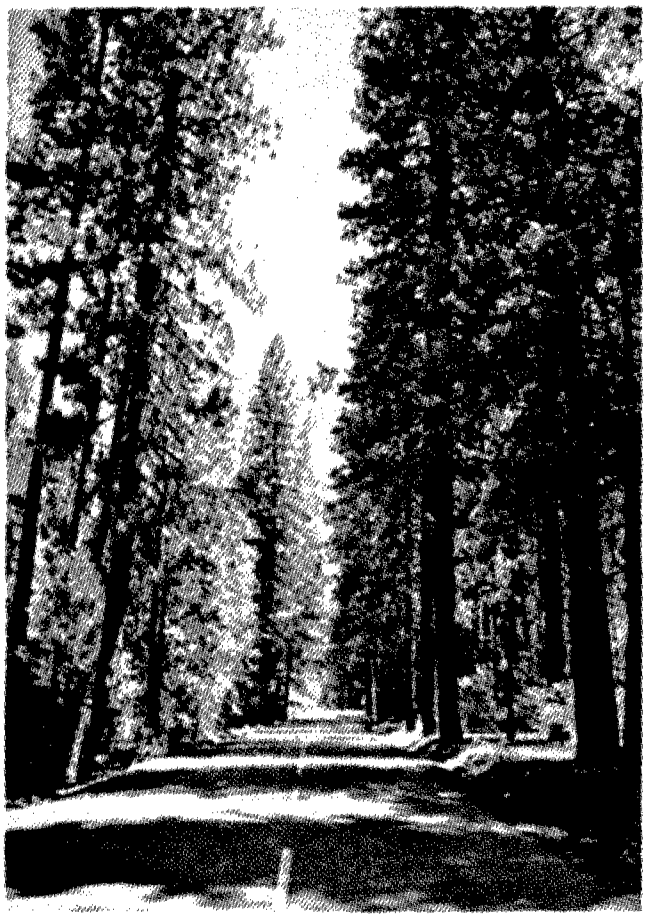
"Experience, we may see, is compounded of that which we have perceived, that which we are perceiving, and that which we expect to perceive."

—John O. Simonds

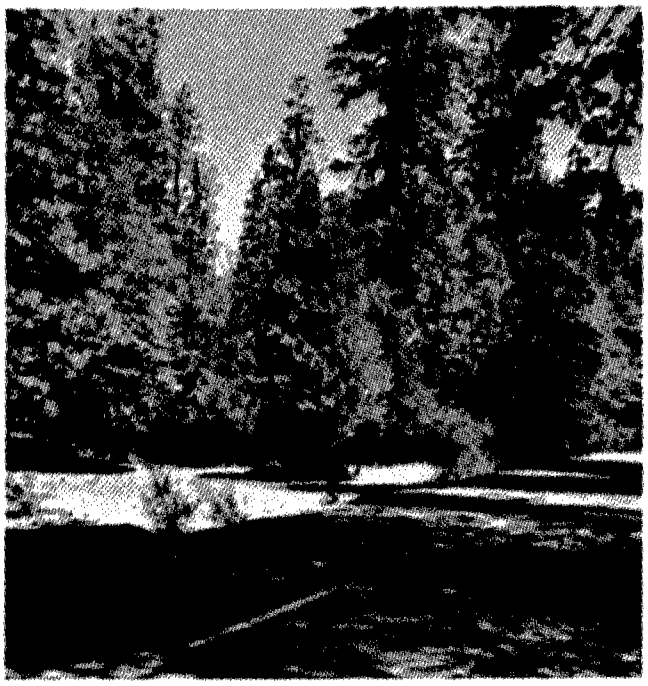
Sequence may be thought of as a progression, the visible experience of movement or change. Sequence in the visual sense is a series of events which lead the eye in a specific direction or exhibits a logical order. A line of trees becomes a sequence if the eye automatically follows from one tree to another. Designers utilize this principle to create an experience by visually linking one event with another in order to direct the eye to a desired point. A logical sequence unconsciously builds excitement, an anticipation of something more to experience. A pleasant type of rhythm develops in a properly planned sequence which imparts the feeling that one is, in fact, progressing in some direction. A design that incorporates a sequence creates a pleasurable experience for those who move through it rather than a static feeling of monotony.

"Our impressions of an object or a space are conditioned by those objects or spaces we have already experienced or that we anticipate. . . : We plan, then, not a single experience alone, but rather a sequence of conditioned experiences that will heighten the interacting pleasurable impact of each."

—John O. Simonds

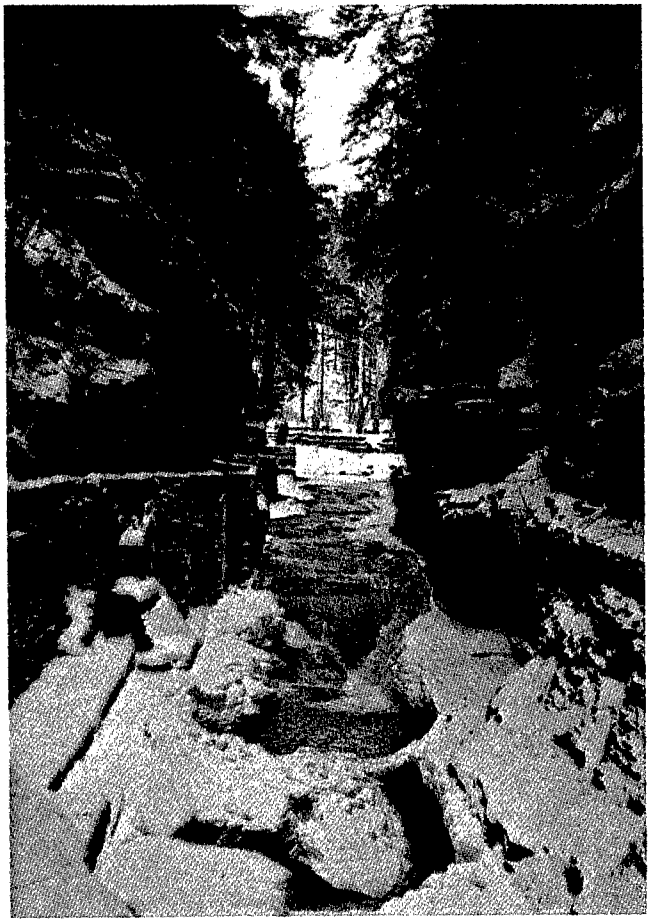


A sequence created by selective openings in a forest

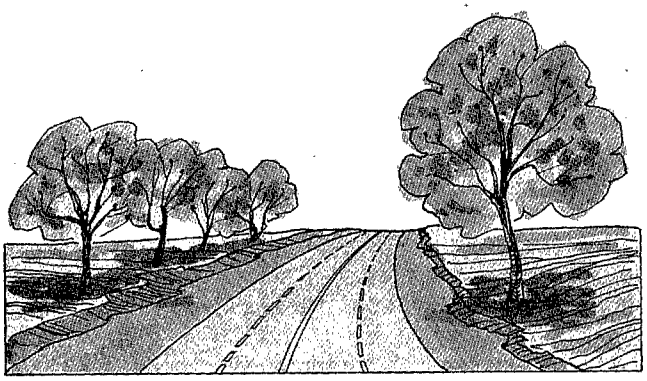


Axis is a visible or invisible line that bisects a view. An axis tends to focus attention on itself or on a distant feature which terminates the axis. Most axes divide a view into balanced parts. In nature, the axis often exists, but rarely in a symmetrical manner. Symmetrical forms are mirror images divided by an axial line which is either expressed or implied. Asymmetrical forms achieve a balance through the arrangement, location, and relative size of opposing forms divided by an axis. In an axial view, the eye of the observer is directed forward, toward the center of the view, by the converging lines of the composition. A long, straight highway, on level ground, forms a visual axis which directs the attention of the motorist in a forward direction. A symmetrical axis tends to be monotonous because all components are equal. An asymmetrical axis relieves this monotony, particularly for the moving observer. As one moves through an asymmetrical arrangement, the relationships between opposing sides of the axis constantly change while still maintaining a feeling of order and visual balance. The principles of the axis can be used by the designer to create powerful visual effects through balance achieved in a symmetrical or asymmetrical manner.

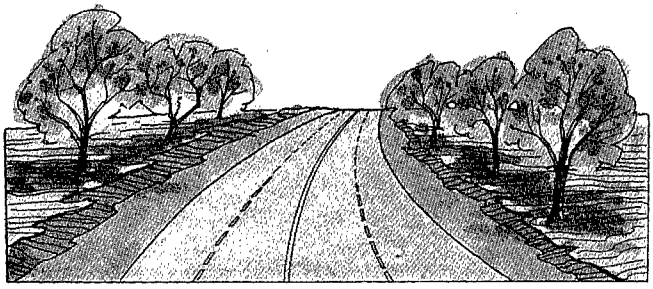
A planned axis



A natural axis



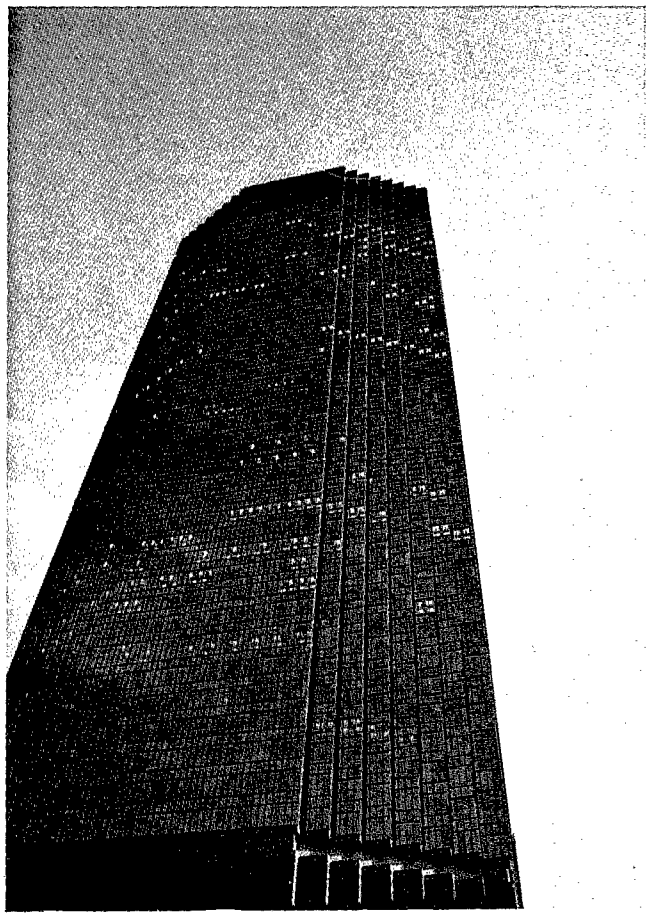
Asymmetrical balance



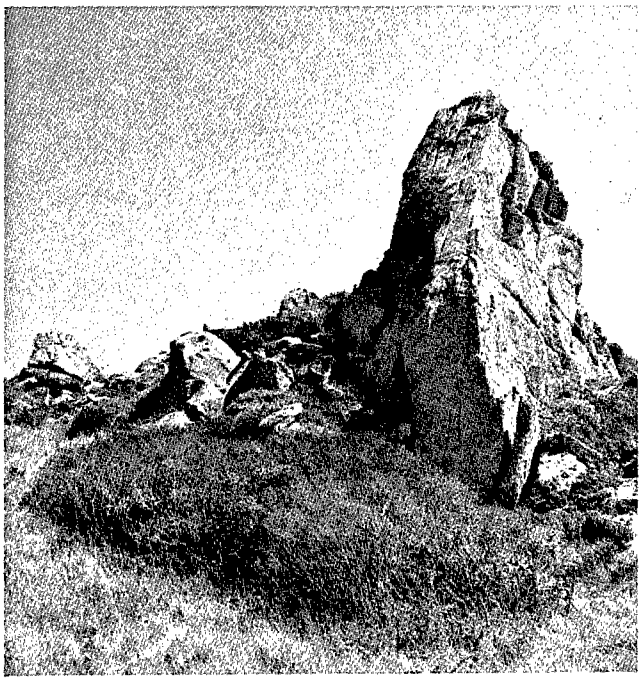
Symmetrical balance

Dominance refers to a comparison between adjacent objects in terms of relative visual importance. Dominant features are superior to all others in visual influence. A view may contain more than one dominant feature: Two objects of equal visual influence are said to be codominant. Many dominant features in a view tend to be distracting; the eye is drawn from one to another without the opportunity to focus on one major element. Dominant features in nature are mountains, a single tall tree among small trees, or any feature that clearly controls the visual scene. Skyscrapers and other major man-made objects are dominant if they exert a strong visual attraction over adjacent features.

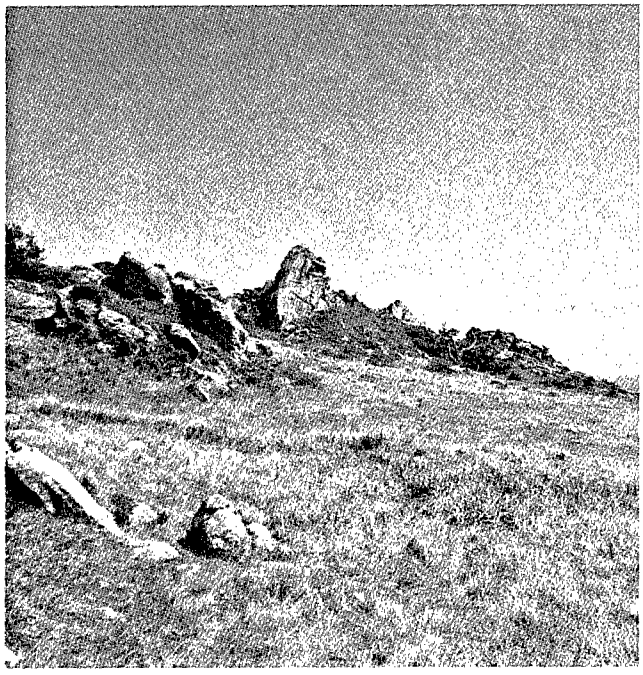
A form dominant by its color and size in relation to other elements



Dominant form



A dominant element in a composition . . .



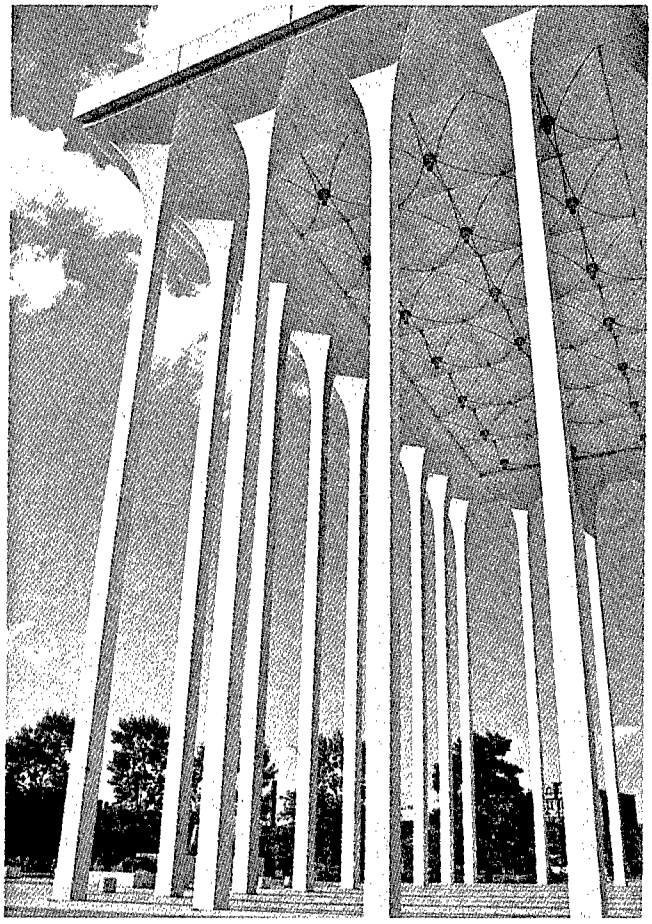
. . . becomes less dominant when viewed in relationship to other dominant elements

Variable Factors

- scale
- proportion
- distance
- observer position
- atmospheric condition
- light
- seasons
- motion

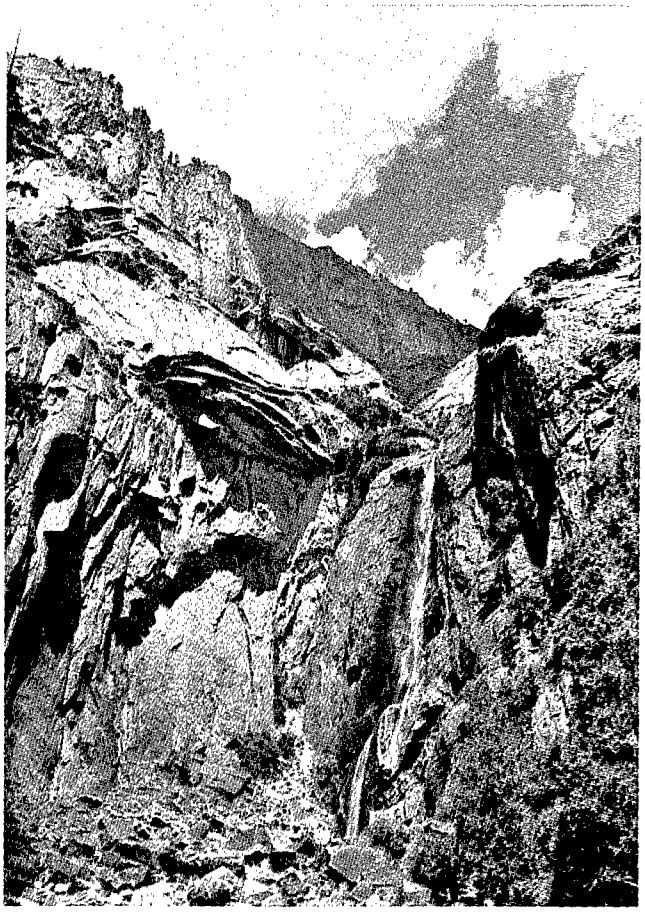
Variable Factors

A number of design components affect or modify what we see, but are not constant because they represent changeable relationships between the viewer and the scene. These relationships are called variable factors. Such factors as scale, proportion, distance, observer position, atmospheric conditions, light, seasons, and motion are important considerations which the designer should be aware of and which may be used effectively in proposed designs.



Monumental scale—in a structure . . .

Scale is the relationship between two or more objects being compared in terms of apparent size. Objects that are in scale appear to belong together. Objects that are out of scale exhibit a visual imbalance; one or more objects appear to be extremely dominant, even overpowering. Scale is often considered to be the relationship between the human figure and other objects. The size of a human is roughly constant; objects that fit well with human size and physical capabilities tend to be in scale.

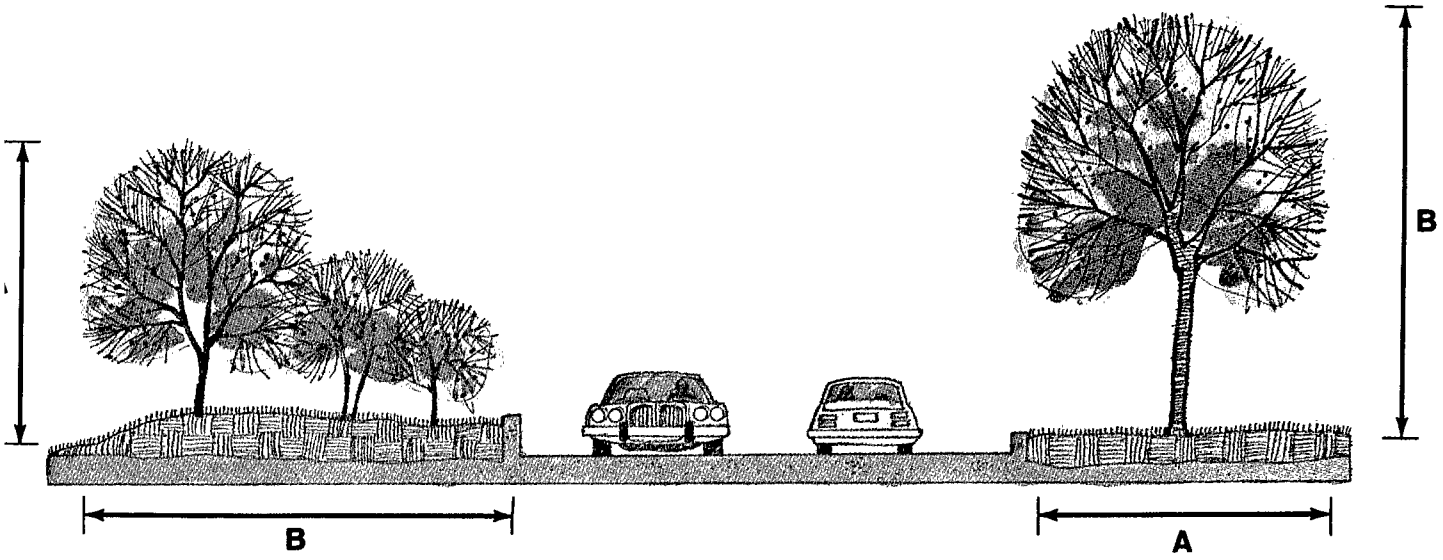


. . . in nature

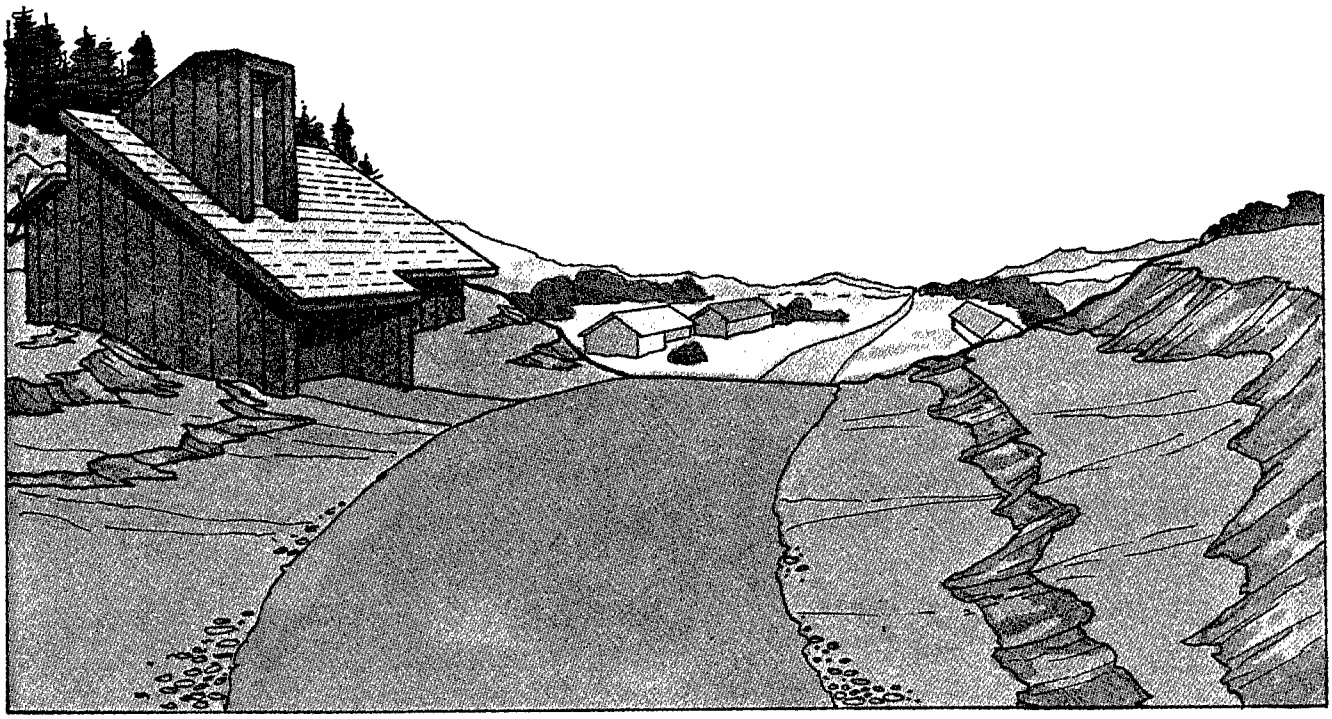
Large scale in a pedestrian space, designed to make the structure dominant

Intimate scale, related to human activity

Proportion is the relationship between components of a single object or composition, such as the ratio between height and width or the relative size of a part in relation to the whole. Components are in proportion to one another when they exhibit a visually balanced attitude; objects not in proportion do not appear to be compatible. Man has studied proportions for centuries, and mathematical ratios have been developed which have been derived from proportions existing in nature. These ratios, when applied to design, create a visually pleasing, balanced composition. For example, the ideal rectangle has been said to have a ratio of 3:5 along its sides. Many other laws of proportion have been developed and are of use to the designer in creating visually balanced, aesthetically pleasing designs.

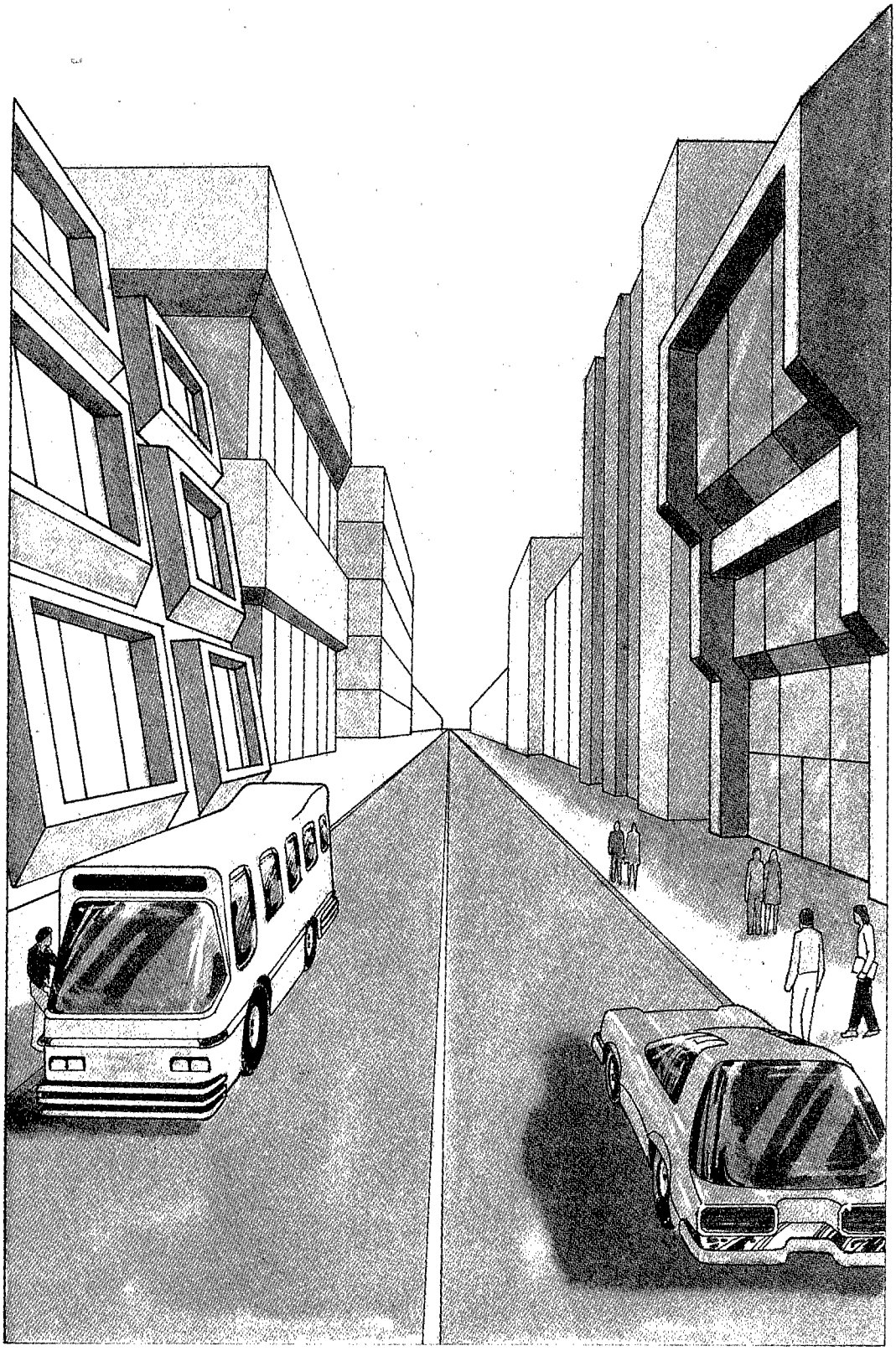


Asymmetrical and proportional balance between adjacent vertical and horizontal elements.

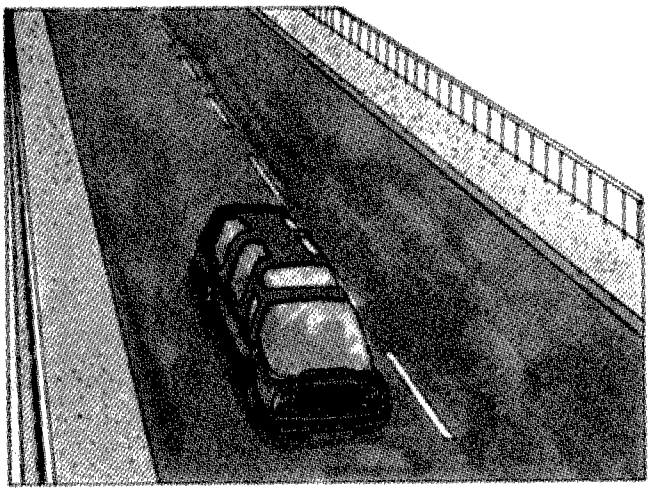


Distance affects our perception of detail, color, texture, and scale. Objects at close range tend to be examined by the observer, and subtle differences become apparent. At greater distance, finite differences in detail become lost, and the observer must rely on color variations or textural differences to discern one object from another. When one approaches the limits of visibility, only objects which greatly differ in contrast are visible. It is difficult to determine the size of a distant object unless one has something to relate it to, such as another person, tree, or other fairly constant figure in terms of size. Outlines of objects become the main form of identification at great distances. This basic principle is important to the designer. Objects which the designer wishes to be seen at a distance should be of bold texture, contrasting in color to their surroundings, and unique in form. Objects which need to blend with their surroundings at a distance should be similar to their environment in texture, form, and color.

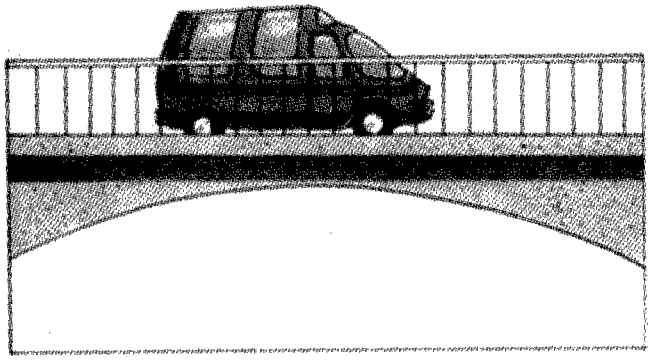
Effect of distance on detail



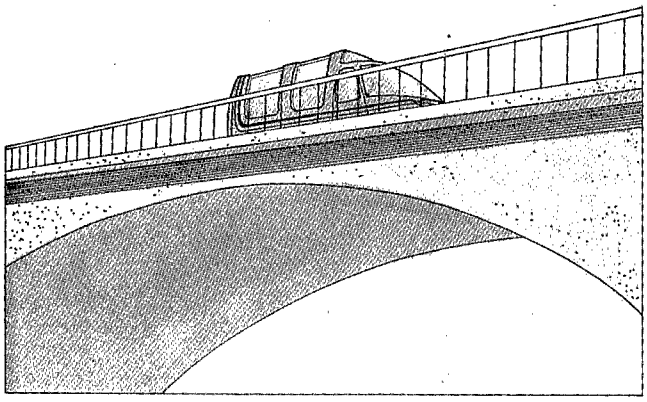
Observer position determines how much of a total object is seen at one time. Objects are most visible from a position above the object; at this position the eye has its maximum peripheral capability—we can see a wider angle and therefore more of a view. Most detail may be seen at a position near to eye level. Objects that are above the observer tend to be dominant; however, we can see less of an object, and it becomes difficult to accurately determine the shape or proportions of the object being viewed.



Observer above



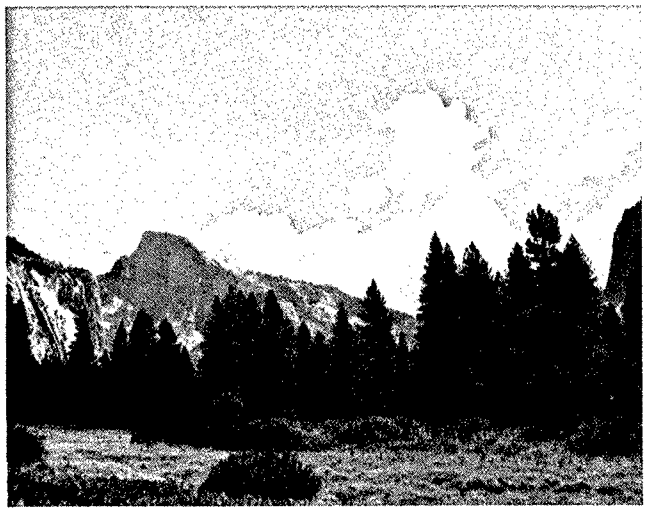
Observer at eye level



Observer below

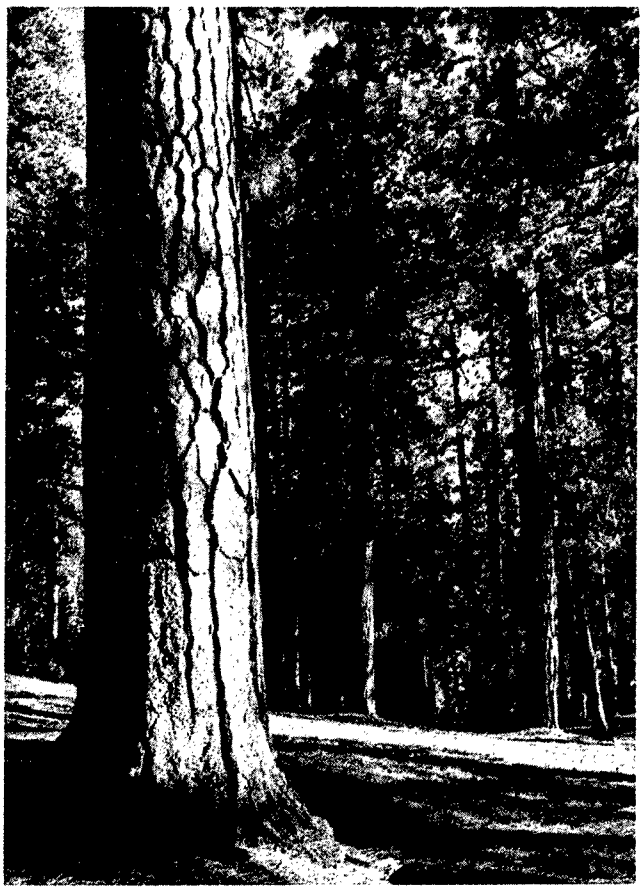
Atmospheric conditions affect our perception of objects by increasing or decreasing visibility. Bright, sunny days maximize color variations that help us to distinguish between objects in the landscape. Cloudy days tend to reduce the contrast of objects, thereby helping to blend one with another; thus colors appear less vivid, somewhat darker. Rain, fog, smog, and falling snow also reduce our visibility and blend colors together—objects are less visible even at close distances.

When choosing colors for a proposed design, consideration should be given to the prevailing atmospheric conditions regardless of whether the design is intended to blend with or contrast with the surroundings.

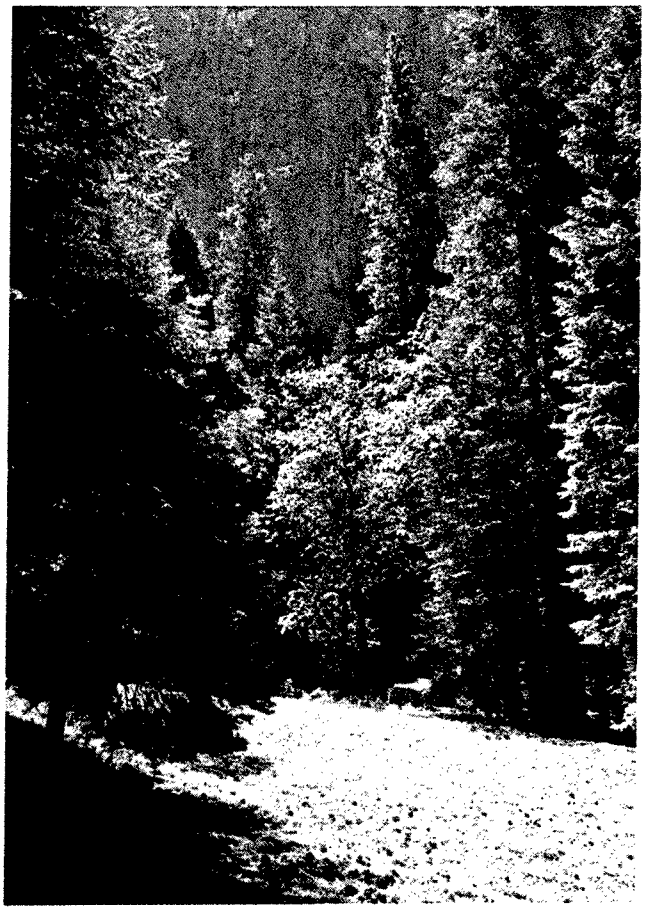


Bright, sunny days increase visibility.

Smog and haze decrease visibility.

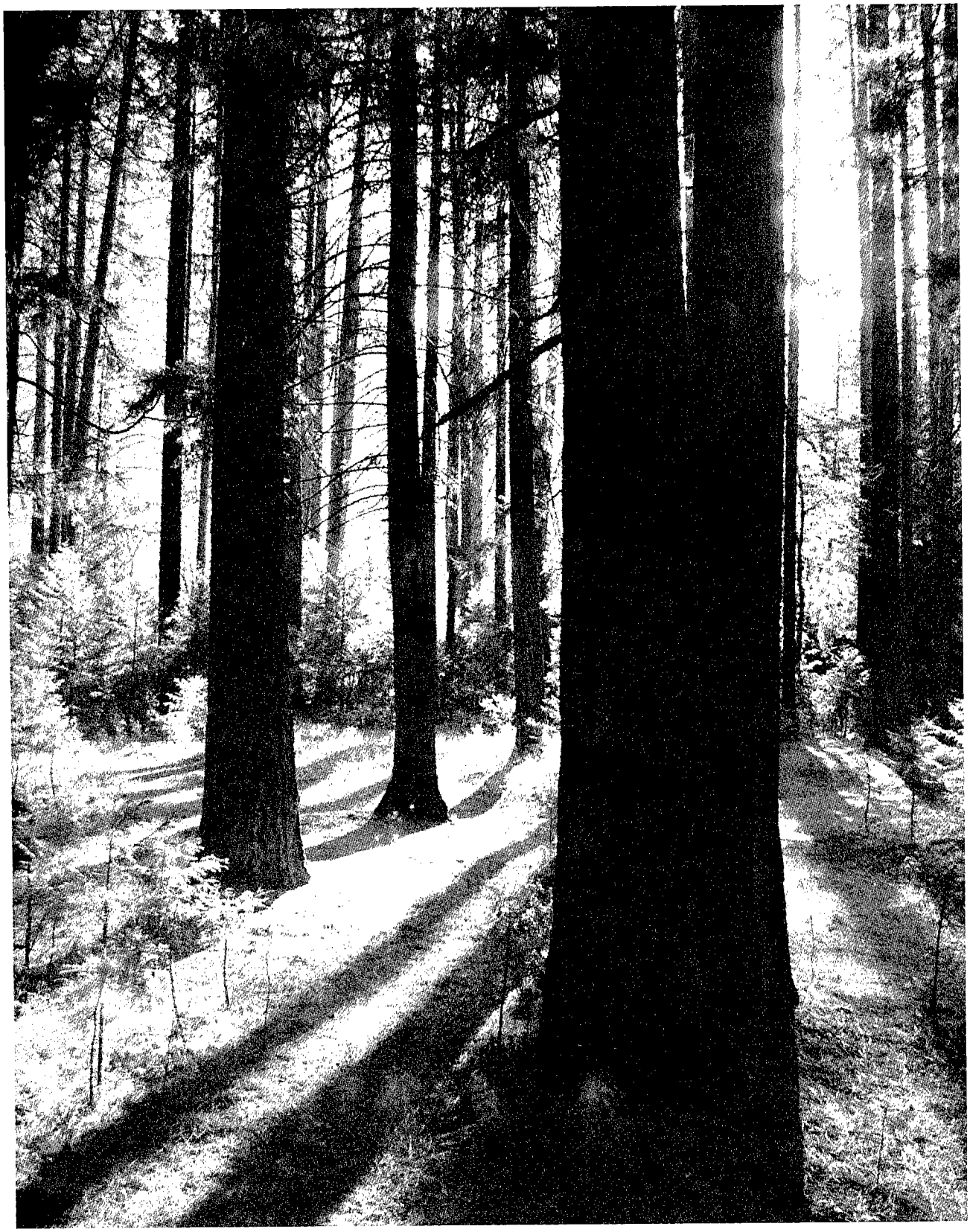


Side lighting—awareness of three-dimensional form of objects

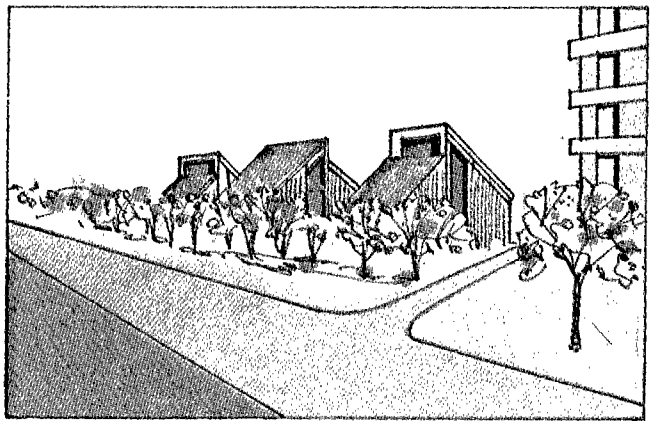


Front lighting—bright color, high reflection, flat, two dimensional look

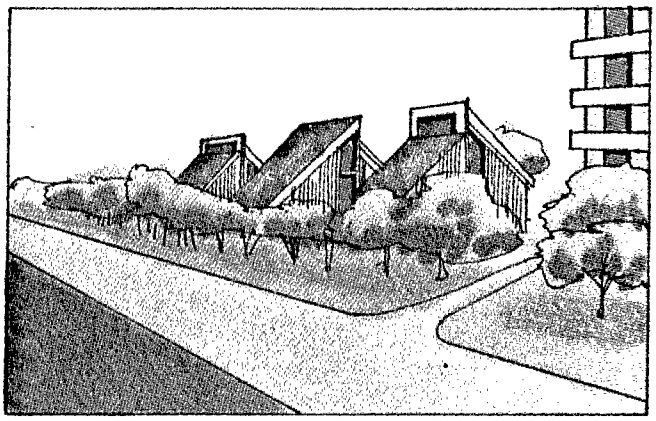
Light plays an important part in our perception of objects. Bright light aids in color reflection and general visibility. The direction in which the light source strikes the object in relaton to the observer determines what we see. Objects that are back lighted are distinguished by their form—details of the object are lost; the silhouette becomes the major feature. Objects which are front lighted reflect the most light; therefore, colors become the most obvious feature. Front lighted objects tend to appear two-dimensional or flat, because little shadow exists under these conditions. Side lighted objects benefit from the shadows created, and textures are more apparent. Objects appear three dimensional; the viewer can distinguish depth at greater distance. Side lighting conditions create dramatic effects in nature in late afternoon to evening which is one reason a drive in the outdoors is so pleasant at this time of day.



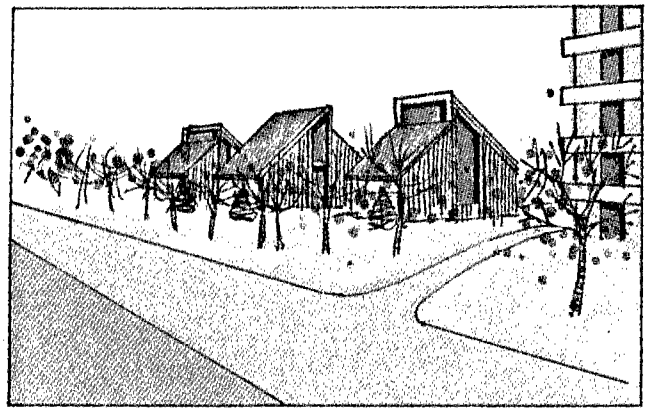
Seasons affect our visual perception due to the wide variation in color of the surrounding environment. Spring flowers and fall leaf colors tend to dominate in the environment and negate other features. In summer, green or brown colors predominate in the landscape; colors which do not harmonize well with these colors tend to become more apparent. In winter, predominant colors tend to be browns or shades of gray and white in snow country. In snow, much of the landscape and colors are negated except for major structures, trees, etc., which become more dominant as a result. Objects which have little visual impact for most of the year become major landscape features due to the heightened contrast and increased awareness of line and form.



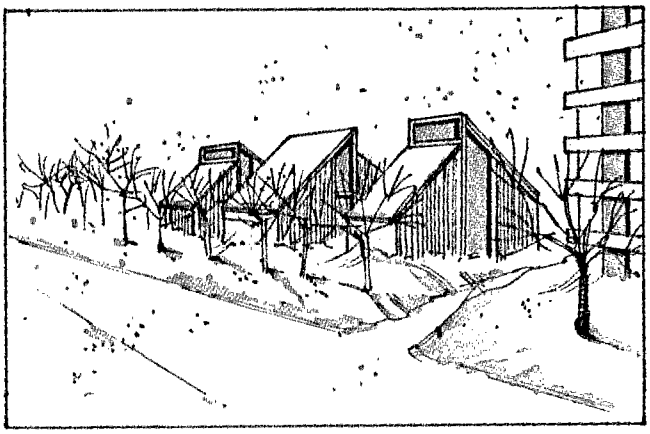
Spring



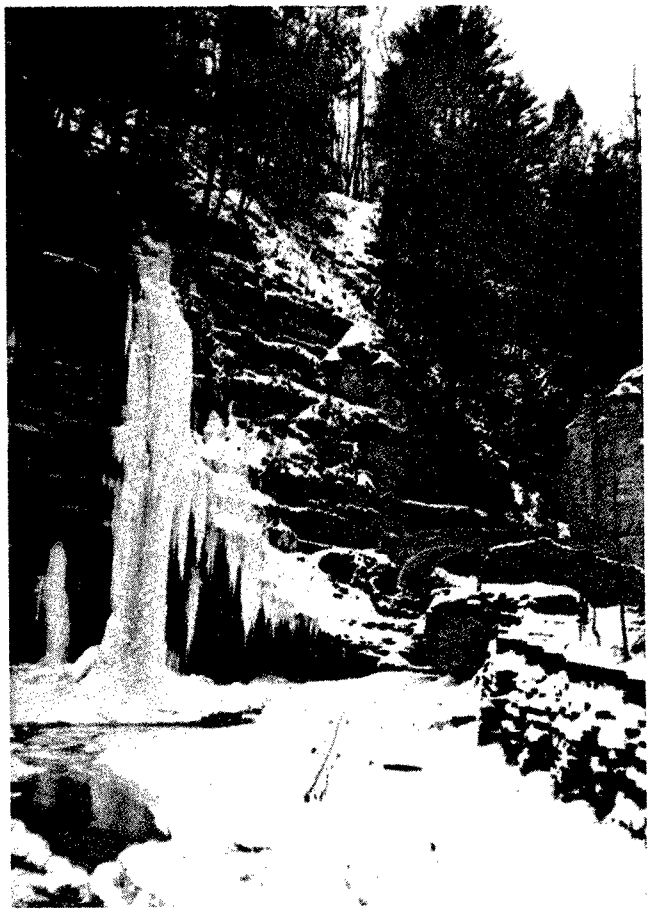
Fall



Summer



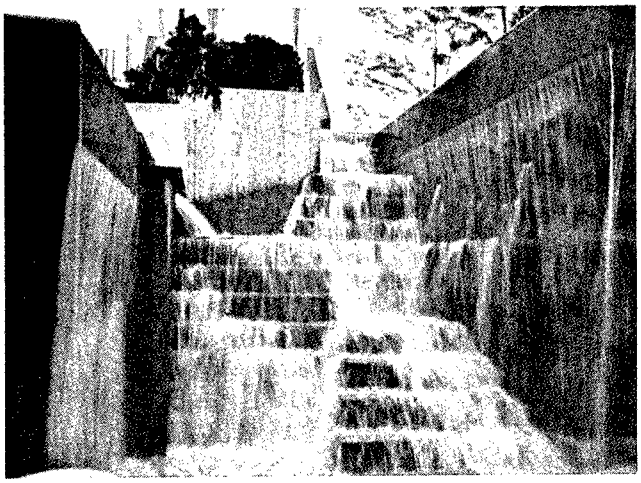
Winter



Seasonal changes produce unique visual effects.

Fall colors tend to dominate in the environment.

Motion affects our perception of detail. When the observer is in motion, fine detail or subtle differences in texture are lost; the observer relies on color and form as an aid to identification of objects. When the observer is stationary, motion attracts interest; the eye tends to follow the motion or to determine what is moving. Slow motion attracts attention to detail in the composition of objects rather than in the objects themselves. The motion in such things as fire and rushing water accounts for the ability of these features to attract and hold attention for long periods of time.



Motion

Chapter 4

Application of Principles

Major Elements and the Noise Barrier

Coordinate Elements and the Noise Barrier

Variable Elements and the Noise Barrier

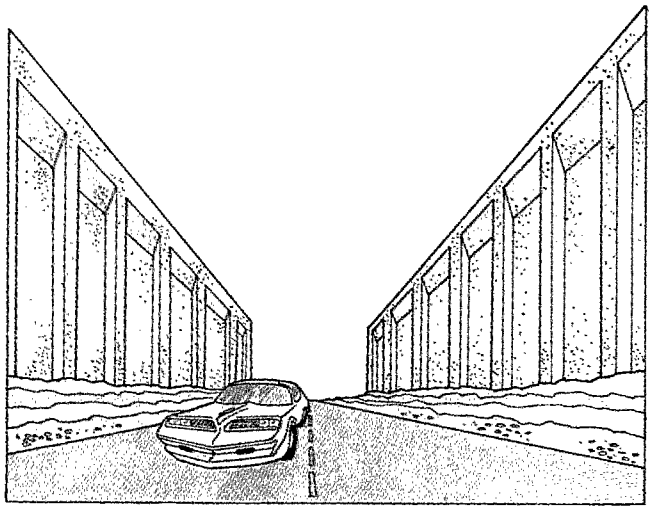
Application of Principles

Highway noise barriers tend to dominate in the environment since they must be placed close to the roadway, frequently extend for thousands of feet along the right-of-way, and often must be over eight feet (244 cm) in height to be effective. Some barriers in existence today range in height from ten to twenty-five feet (3-7 m) above the road surface. Clearly, the potential for adverse impact may be minimized by utilizing design principles in the planning process, and by a thorough analysis of the site and existing conditions prior to design. This chapter illustrates the relationship between principle and actual circumstance.

Major Elements and the Noise Barrier

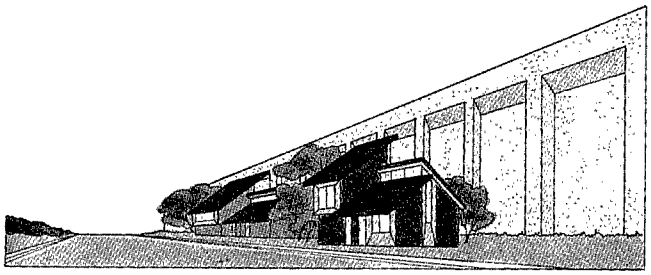
The Noise Wall: Line and Form

The line and form of a noise barrier are its two most dominant features. The line of a noise barrier is expressed as its outline in plan view, and as its top surface in elevation. Both are equally important visually to the motorist and highway neighbor. Long straight lines are monotonous and make a wall seem longer than it actually is. The effect on the motorist is that of being enclosed, as in a tunnel. High walls adjacent to a roadway tend to create anxiety in motorists—they slow down and unconsciously attempt to move away from the wall. The effect of a high, straight wall on the highway neighbor is that of forced enclosure, as if in prison—corresponding negative attitudes about the wall may develop particularly if the wall is bare, without visual interest. The designer should consider the line of the noise barrier as a possible adverse visual impact and examine alternatives for reducing this impact.

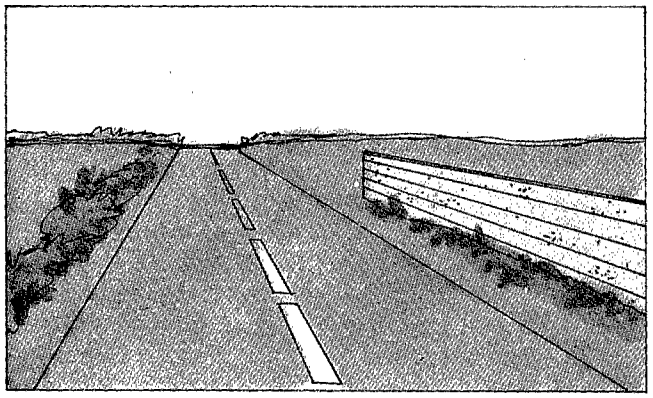


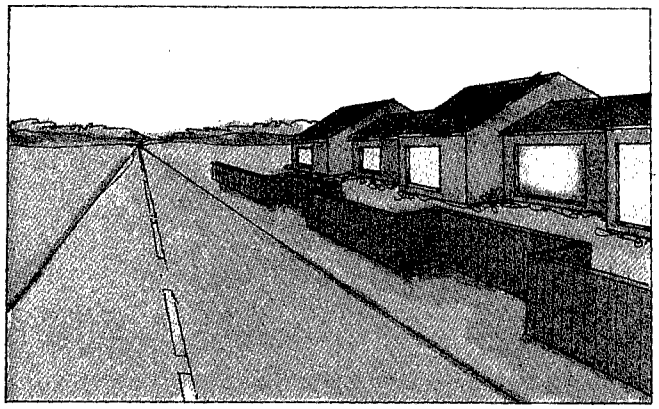
Tunnel effect of high wall

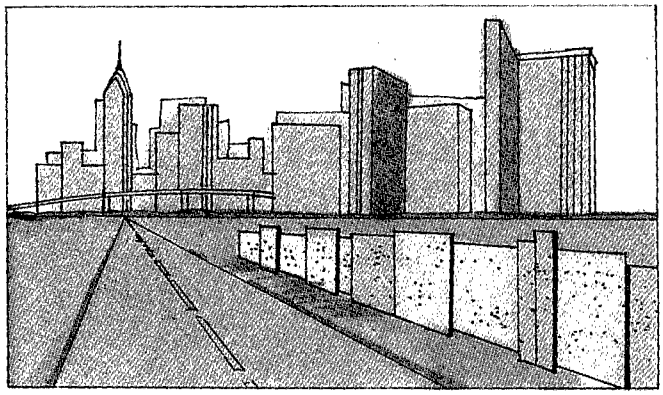
The line of a noise barrier should reflect similar lines of the surrounding environment. In rolling terrain, a straight line seems out of place and attention is drawn to that line. However, in flat terrain, where the horizon is visible as a straight line and the highway is straight, a straight line in a noise wall may be appropriate. A uniform top line of a wall would be appropriate in this case. Where horizontal lines are evident in nearby structures, a horizontal line would be suitable in a noise wall. In an urban situation, where the horizon is composed of alternating heights of buildings, an appropriate top line of a wall might vary in height, as a reflection of the lines on the horizon.



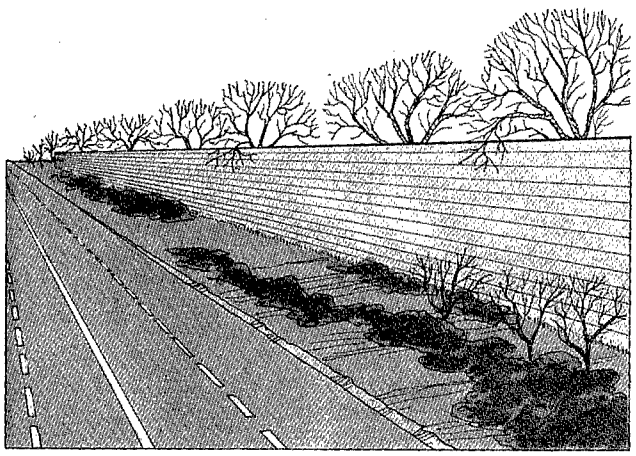
Forced enclosure, a prison-like effect





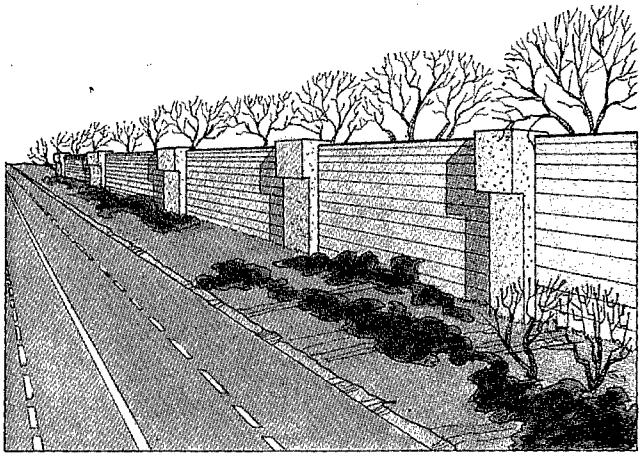


Lines which reflect similar lines in the surroundings



A strong horizontal line

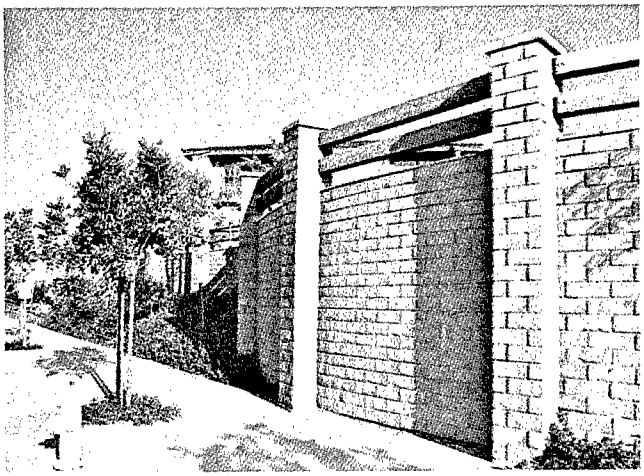
Horizontal lines tend to make an object appear longer and lower. Vertical lines have the effect of added height and tend to make an object appear more narrow. Noise walls tend to be long and high; therefore, both horizontal and vertical lines, if used improperly, may emphasize undesirable features in a wall. Horizontal lines are difficult to utilize in rolling terrain and should be avoided in this situation. Vertical lines should be avoided on extremely high walls. Combinations of horizontal and vertical lines may be effective where extreme height is a visual problem.



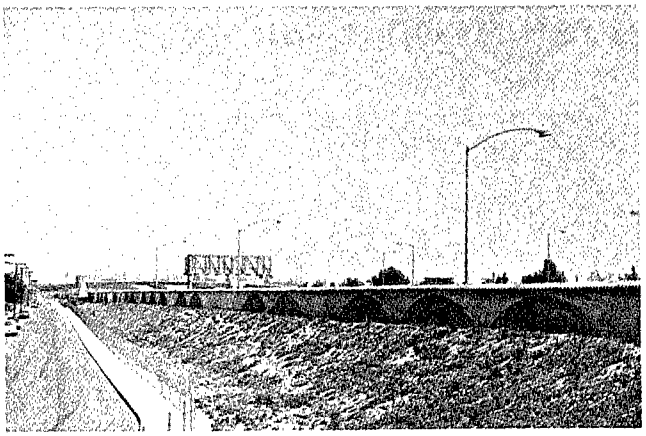
Addition of vertical elements breaks up strong horizontal.

Noise walls are necessarily long and predominantly horizontal. The visual imbalance caused by this situation can be reduced through design. The introduction of a vertical element is the key to proper visual balance. A vertical line should be distinct and massive enough to register as such. Noise barriers, as strong horizontals, need a correspondingly strong vertical for asymmetrical balance. Strong verticals may be designed into a wall, through the use of pilasters, which further serve as structural support.

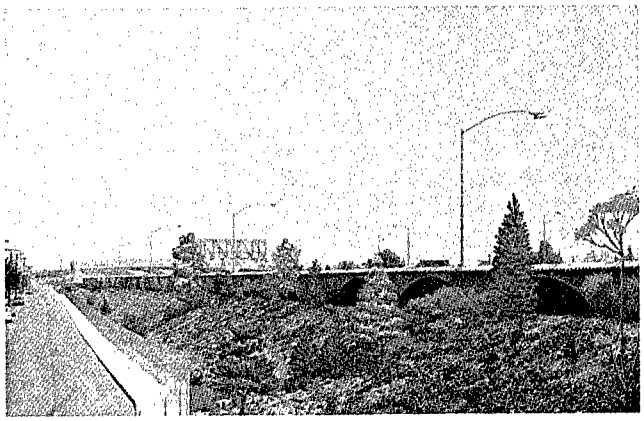
Plantings can be effective means of emphasizing vertical lines in a noise barrier. Columnar trees can be used even where space is limited. The use of vertical lines in the form of trees or through wall design should be as an accent, a balance with the horizontal. One should not replace predominantly horizontal with predominantly vertical lines. Care should be taken to achieve a balance between the vertical and the horizontal lines in noise barriers.



Pilasters serve as vertical elements in this wall.

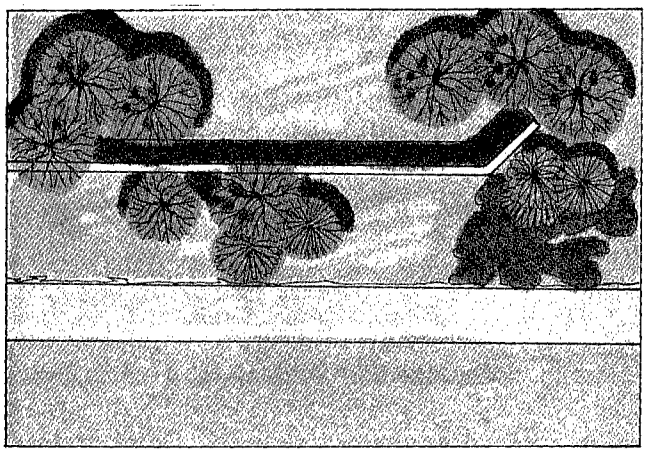


A strong horizontal line evident in a noise wall.

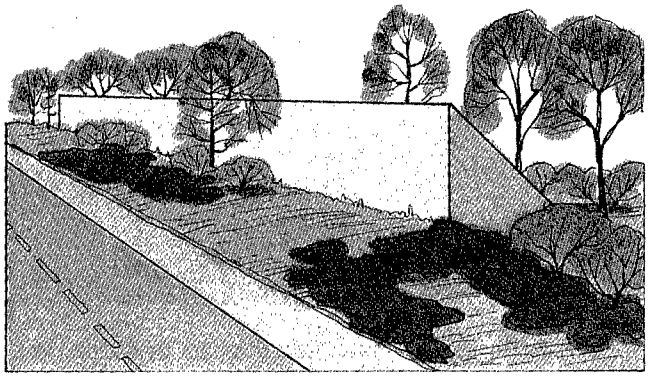


Apparent horizontal line diminished through the introduction of vertical elements in the form of plant materials.

A return on a wall



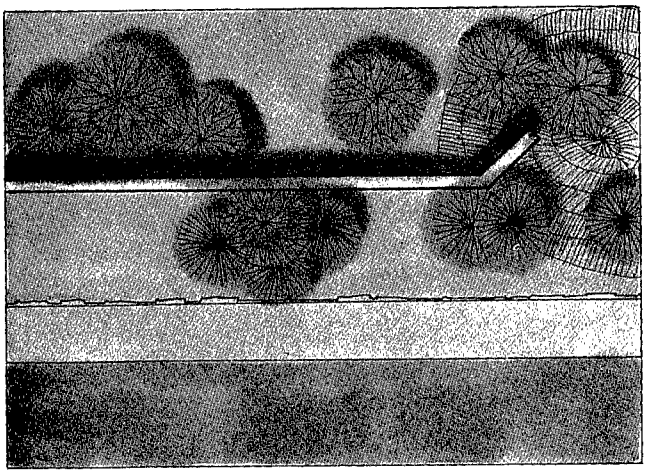
Plan view



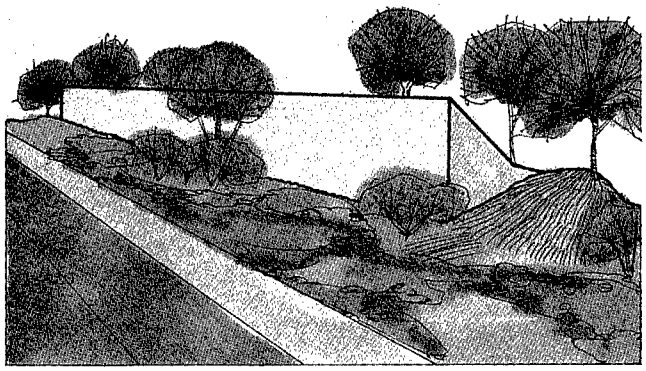
Perspective view

Noise walls which begin and end abruptly and consist of straight, unbroken lines often appear to be discordant elements in the landscape. These should appear to be a part of the highway scene wherever possible, and not give the impression of being placed as an afterthought. Walls should begin and end in a natural transition from ground plane to the desired height. Where space allows, the best transition is through the use of an earth berm or by tying the wall into the natural hillside. The line of the wall then appears to originate from the landscape. Abrupt endings on walls should be avoided; if at all possible, a return should be planned, which carries the line of the wall away from the eye of the viewer. This reduces the unpleasant, unfinished look which generates the impression that the wall might collapse at any moment. This may further be avoided by either a gradual tapering of the wall to a point near the ground or by stepping the wall in even increments until a point is reached where the wall is no longer visually dominant. Where possible, walls should tie into existing structures such as bridge abutments, retaining walls, etc., in order to achieve continuity of line.

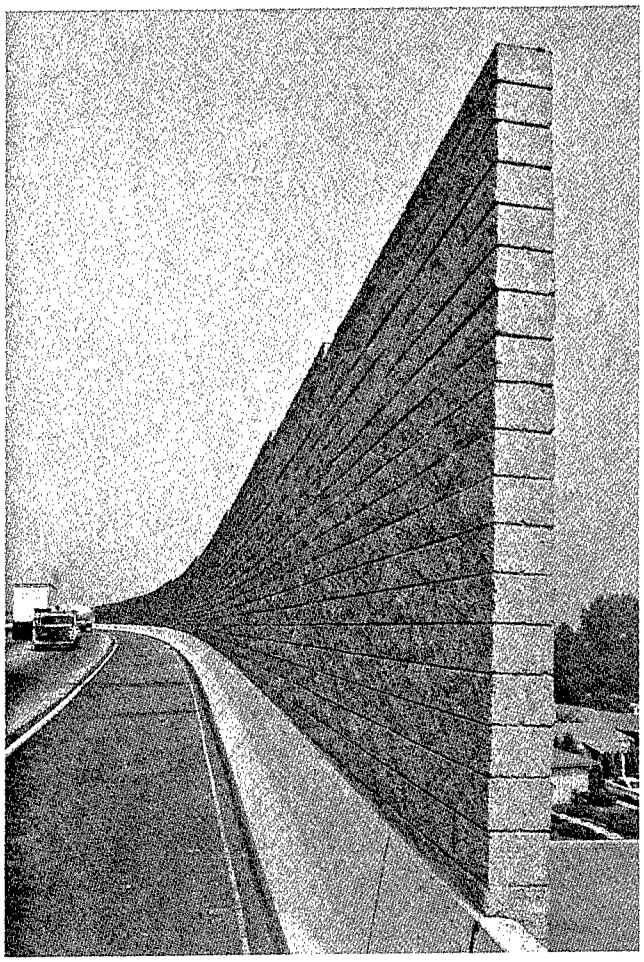
Wall ending in berm



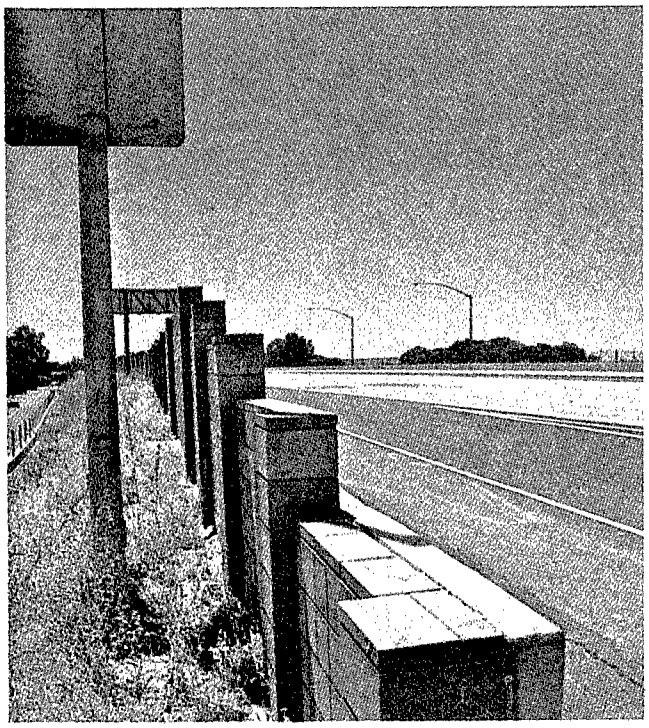
Plan view



Perspective view

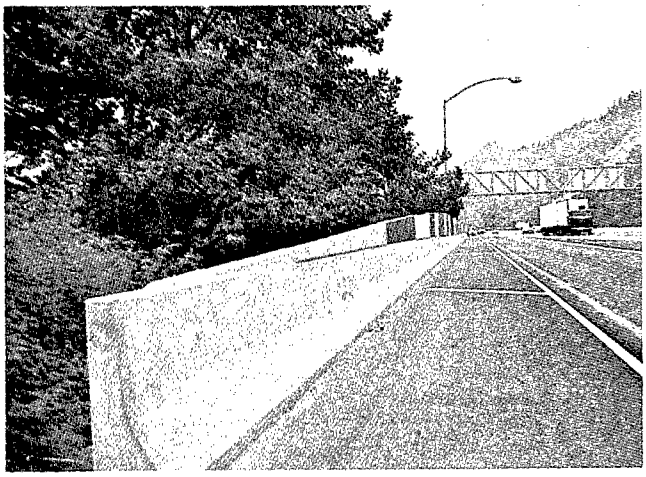


Avoid abrupt endings on walls.

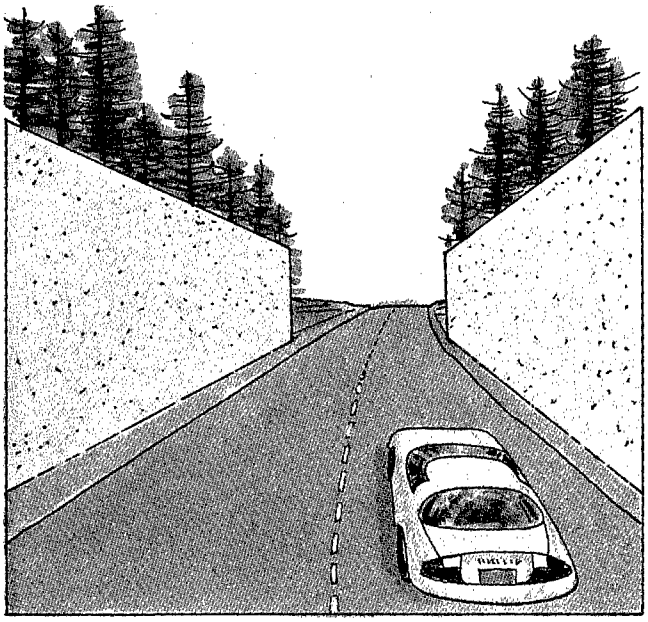


A wall which steps down gradually reduces visual impact.

An ideal situation—tying a wall into a natural hillside or . . .

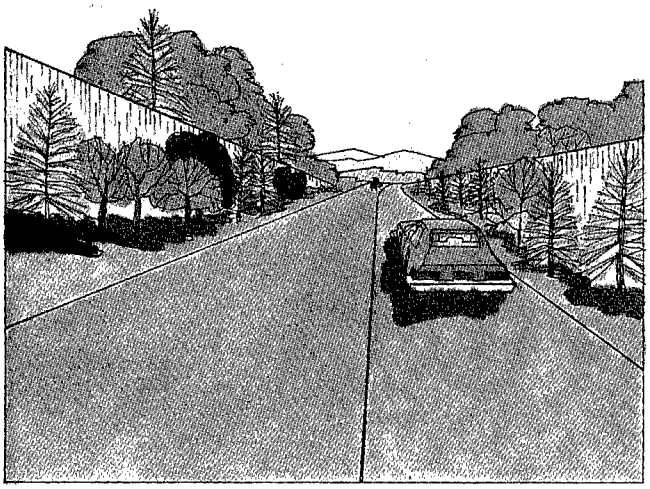


Gradual tapering of a wall

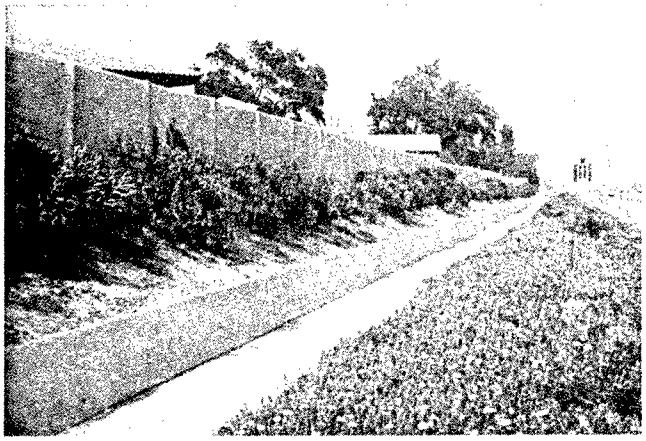


Undesirable: restricted view

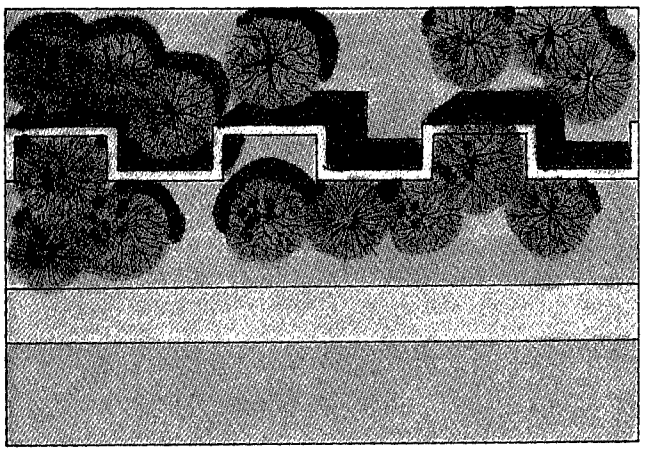
An effective method of reducing visual impact is through multiple walls, arranged in tiers, with setbacks of several feet or more between successive tiers. This has the effect of reducing the apparent height of the wall; the tunnel effect, a tight constricted feeling of enclosure, is minimized when the top of a wall recedes from view rather than encroaching upon it.



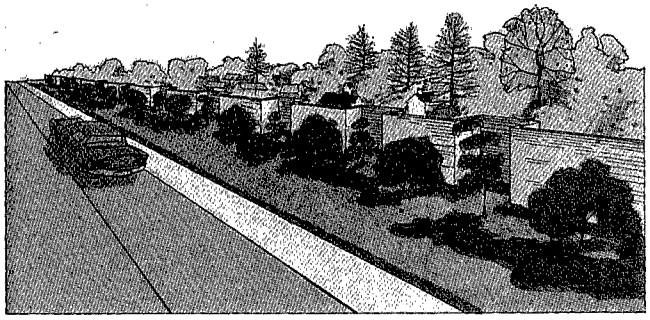
Desirable: walls which step back open up the view



A castellated wall

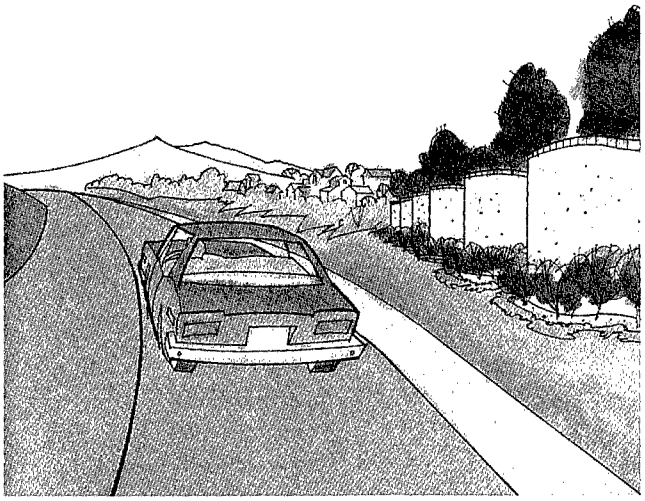


Plan view



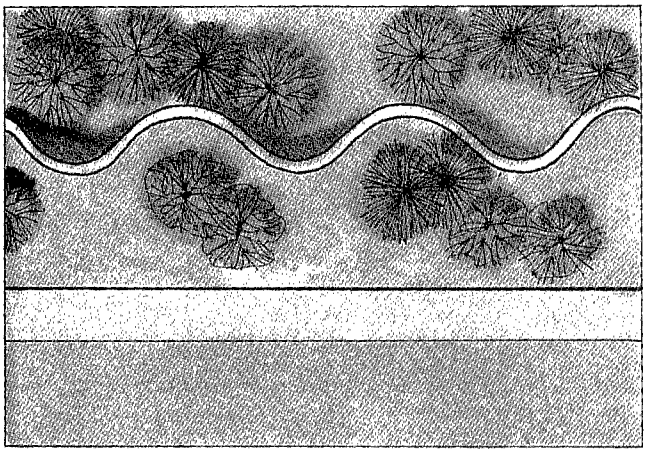
Perspective view

The line of a wall may vary in plan view in order to reduce the straight line effect. This is known as a *castellated* wall. A series of jogs in a wall serve to break the monotony of a straight wall and create pockets which may be used for plantings. The breaks may further be used as transition points for change in texture, color, or wall height. The line may vary in a curvilinear manner to produce a *serpentine* wall, which likewise creates visual interest in a wall, and provides the opportunity for planting pockets. Serpentine walls should be composed of large arcs consistent with the relatively massive scale of the wall and the highway. Both serpentine and castellated walls may be constructed with two or more tiers to create visual interest and further relieve the constricted feeling associated with a high wall. An added advantage in serpentine and castellated walls is free-standing structural strength, a requirement in noise barriers.

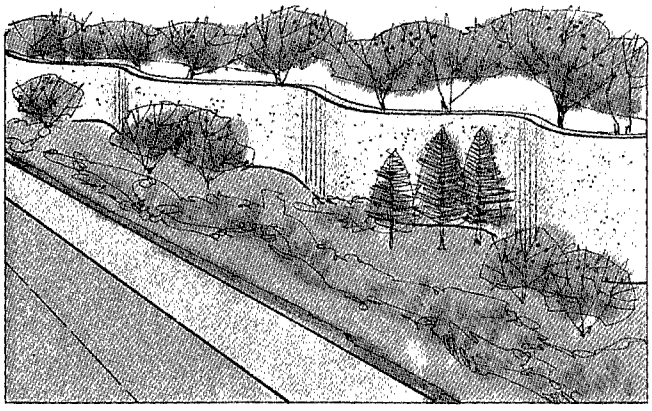


Serpentine walls

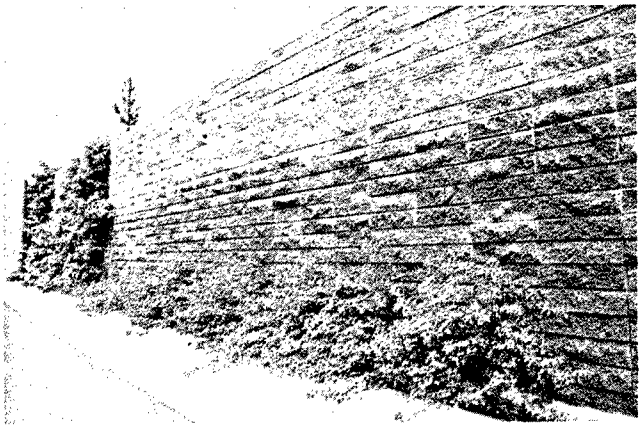
A serpentine wall



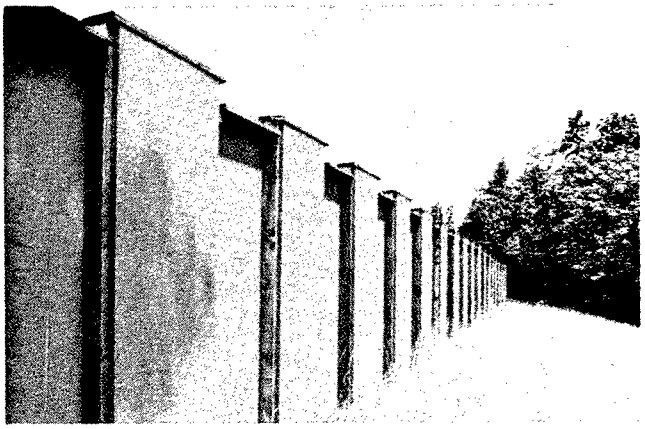
Plan view



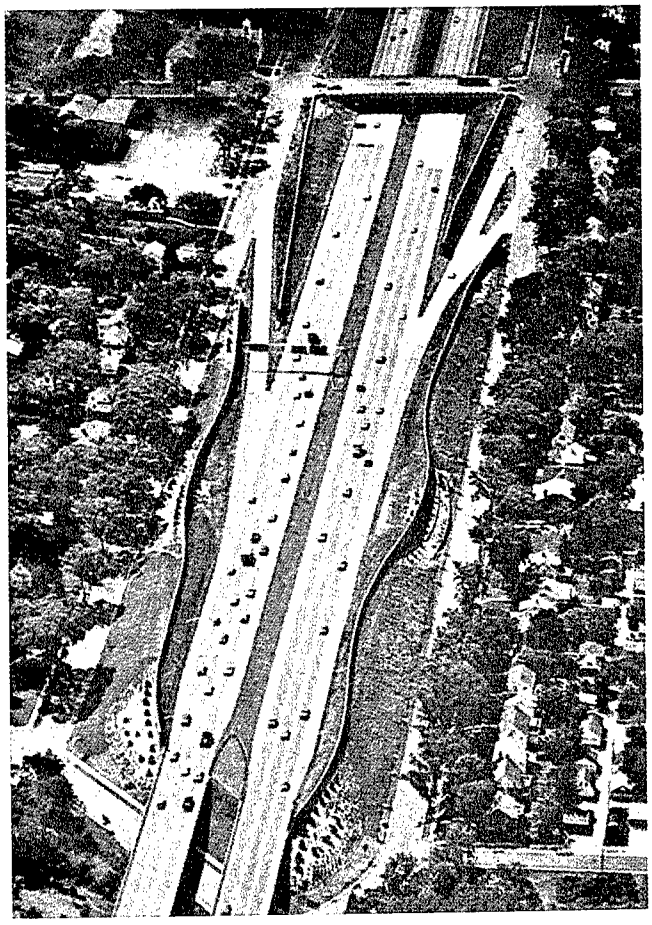
Perspective view



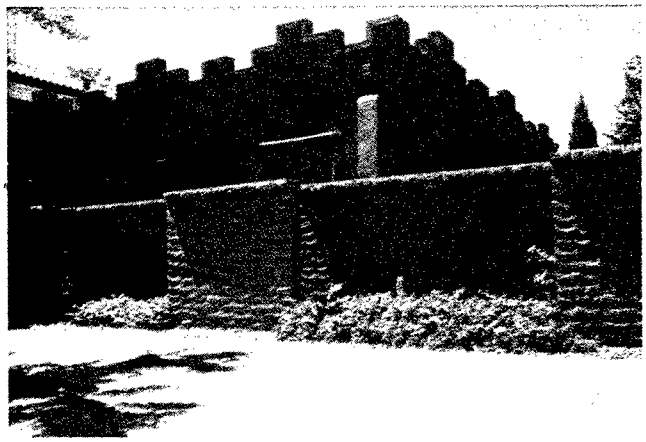
Planting pockets created by jogging a wall. They are also used as transition points for textural change.



A wall which varies in plan view, to reduce the straight line effect, and provide visual interest

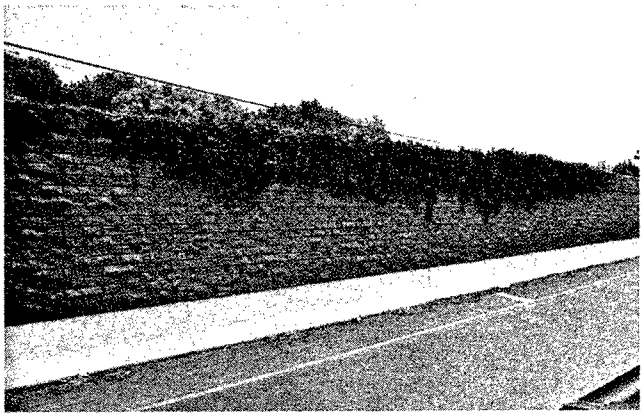


A serpentine wall

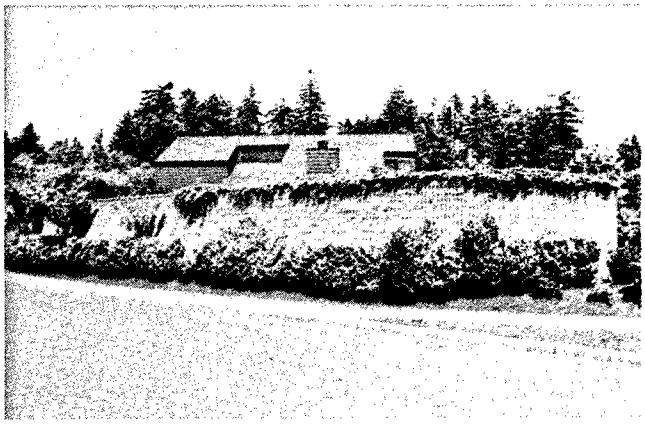


The variation in this wall reflects character of building.

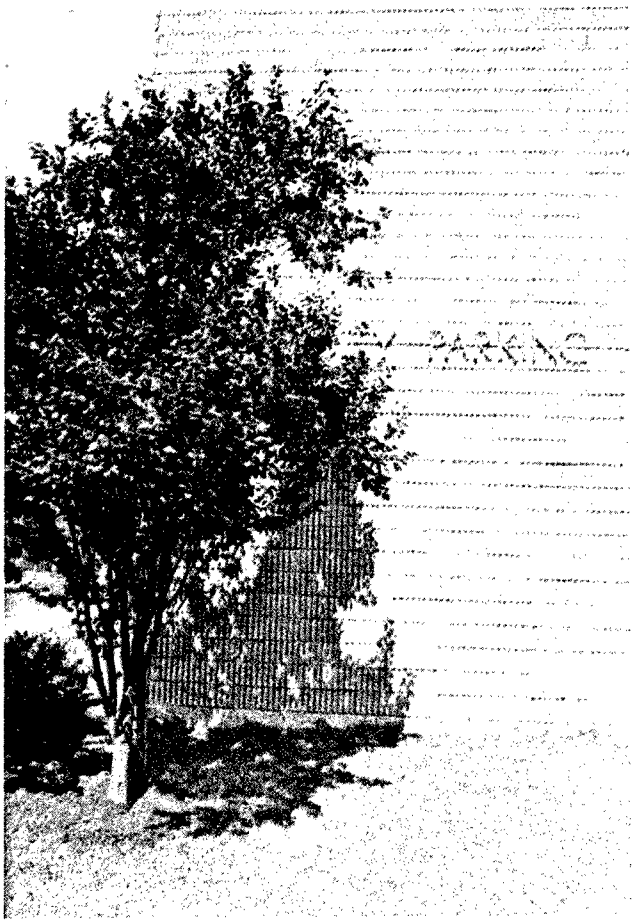
Plantings also may be used to break an undesirable line in a wall. Trees in front of a wall soften the harsh lines; the eye perceives the form and outline of the trees as one with the line of the wall. Vines allowed to grow over a wall will likewise soften an otherwise highly visible hard line. Tree groupings should alternate on both sides of a wall—the viewer becomes less aware of the line of the wall since it becomes part of a composition of forms, rather than a separate element.



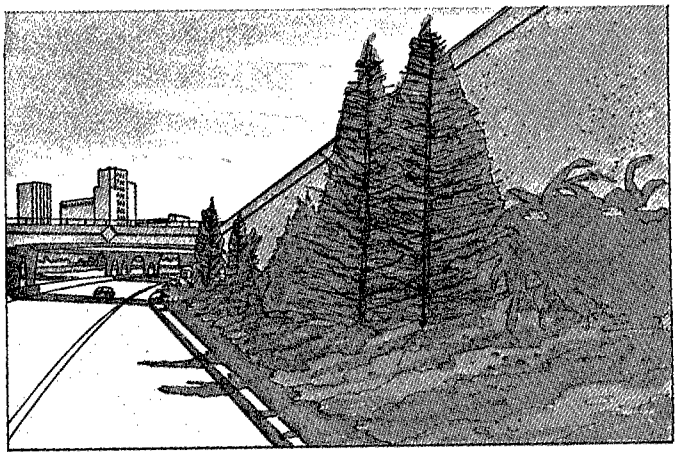
Vines soften the hard lines of a wall.



Vines and shrubs used in combination to soften the lines of a wall



A tree used to soften the hard edge of a wall reduce the dominance of this wall.



Shrubs soften the transition between wall and ground plane.

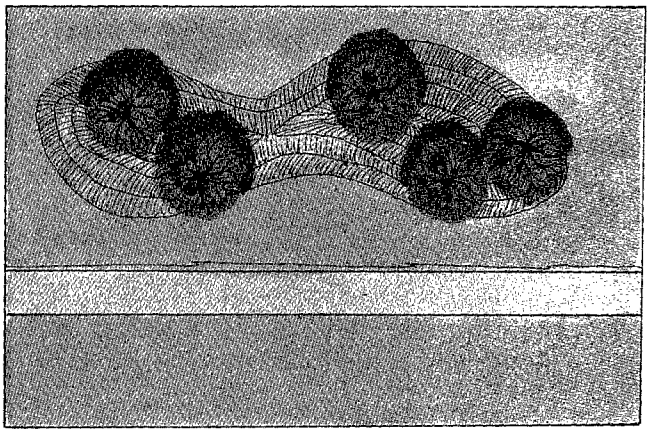
Earth Berms: Line and Form

Earth berms, as the most natural appearing type of noise barrier, should have a line and form similar to a natural hillside. Slopes should approach a 3:1 ratio wherever possible, with transitions in the form of an S curve. Slopes that are steeper than this, with sharply angled transitions, are erosion prone, difficult to plant and maintain, and appear manmade. Rather, one should get the feeling that the berm is a natural landform. Where space allows, the line of an earth berm should vary to further create a natural look. Several berms can be overlapped to create pleasing effects while maintaining noise abatement capability. Plantings should be used as vertical elements on berms, which are distinctly horizontal forms.

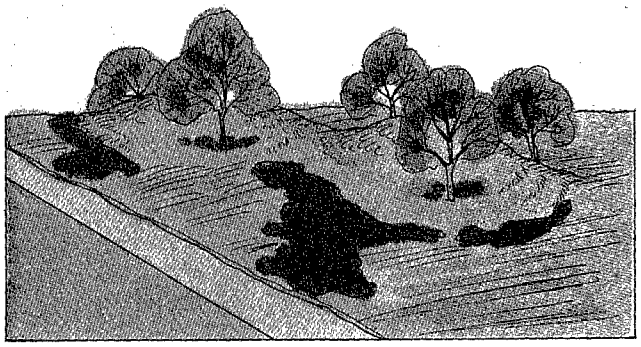
Angle section

S curve section

Earth berm which varies in plan

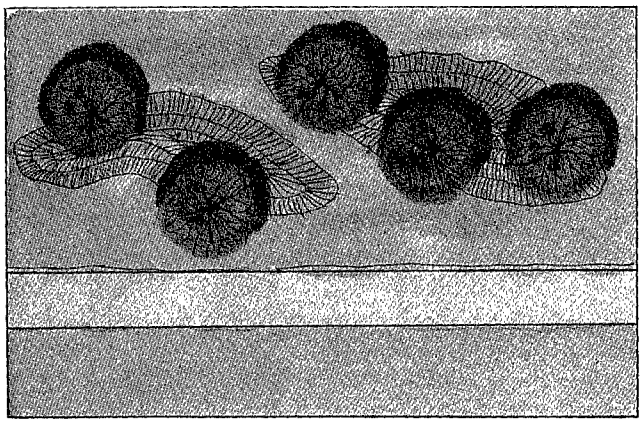


Plan view

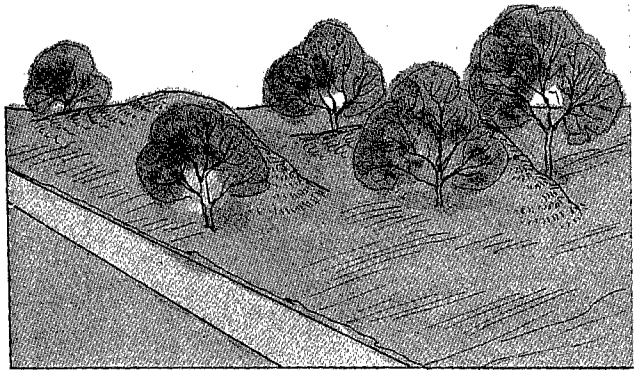


Perspective view

Multiple earth berms



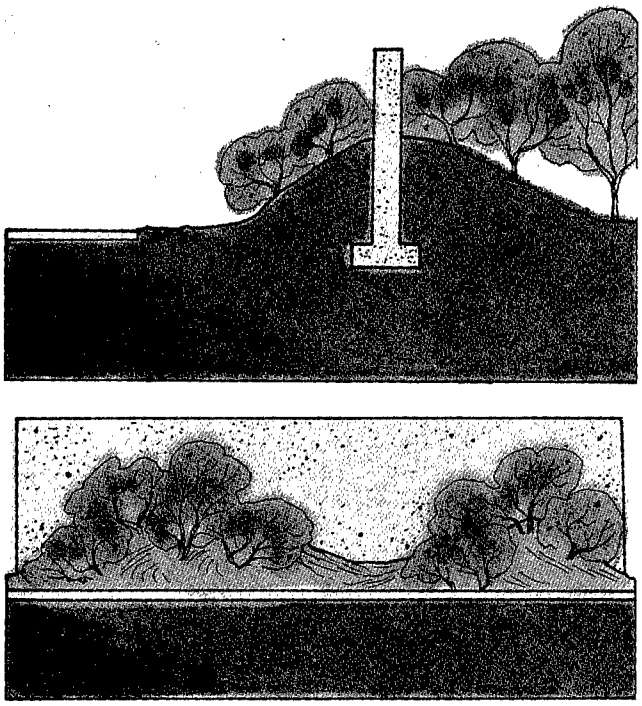
Plan view



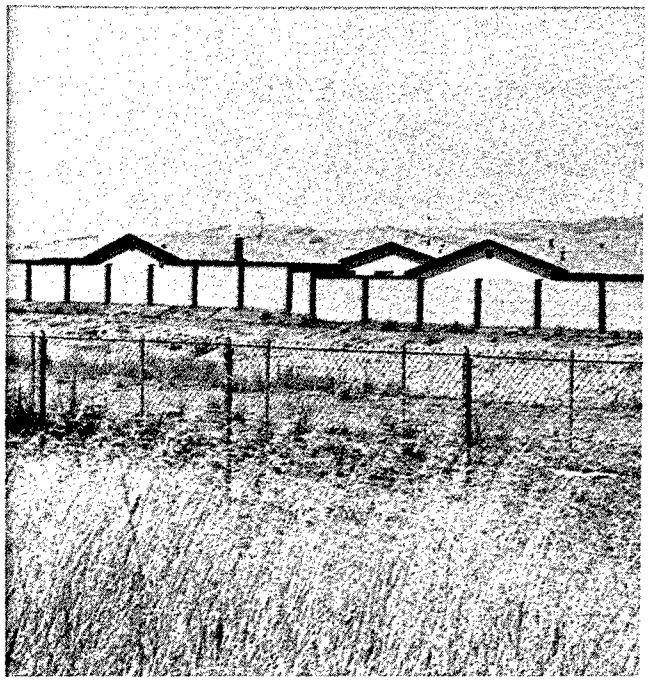
Perspective view

Combination Berm and Wall

Berms may be used in an alternating pattern with walls to break up the undesirable line of a wall. Berms may also be built in front of a wall to reduce the apparent height of the wall. The straight line effect may be diminished by varying the height of the berm in relation to a constant wall height. Noise barriers of this type should always end in a berm that approaches the height of the wall in order to visually tie the barrier into the landscape.



Earth berm which varies in height combined with wall



Wall colors which harmonize well with other colors in the environment

Color

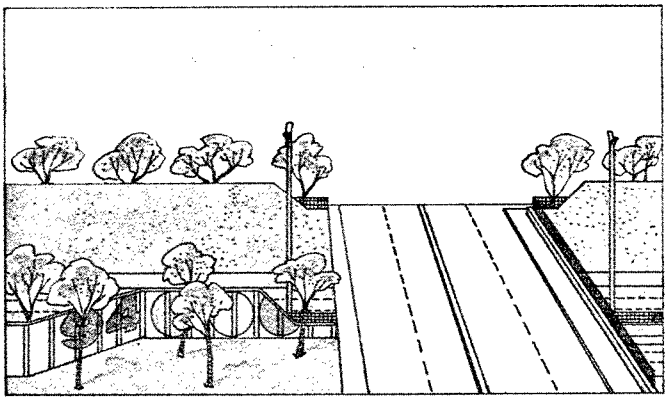
Colors evoke psychological responses. Harmonious colors tend to soothe; contrasting colors tend to attract the eye; and clashing colors irritate. A noise barrier placed along the highway may evoke similar responses in the motorist, depending upon the colors chosen. The motorist should be directed past a barrier with as little visual disruption as possible, because the primary attention of the driver should be on the road ahead and local traffic conditions. The colors chosen for the barrier should reflect and harmonize with the predominant colors of the highway environment in which it is placed. Barrier walls are structures placed in the natural environment. As such, they should not attempt to match the color of trees, grass, or shrubbery because they are not related to such natural features by form. The use of green as a color for such obviously manmade features often reduces visual attractiveness. Rather, harmonious colors should be utilized. The so-called earth colors—browns and grays of various tones—when used on structures in the landscape, help to blend the structures into their environment. Structures which utilize these colors seem to belong to the landscape—they appear to be part of the landscape, rather than an unharmonious element added as an afterthought.

Residents who live adjacent to a barrier become very aware of its existence as part of their environment. In many cases, the barrier results in an interruption of the view and may create an uncomfortable feeling of forced enclosure. In this case, the use of harmonious colors will help to minimize the conscious awareness of the barrier, and will help to blend it into the surroundings.

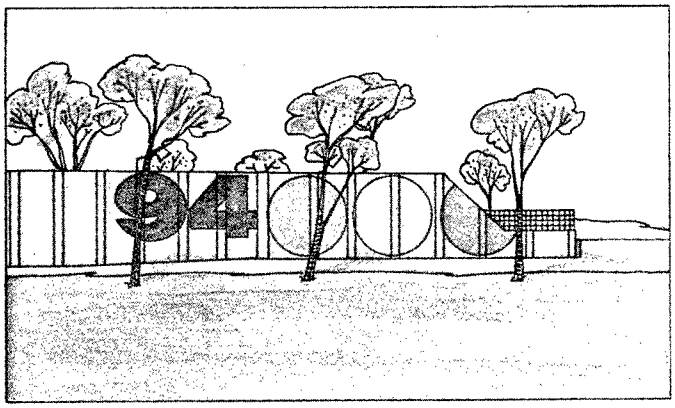
In urban situations, where a barrier abuts on public pedestrian spaces, color may be utilized to other

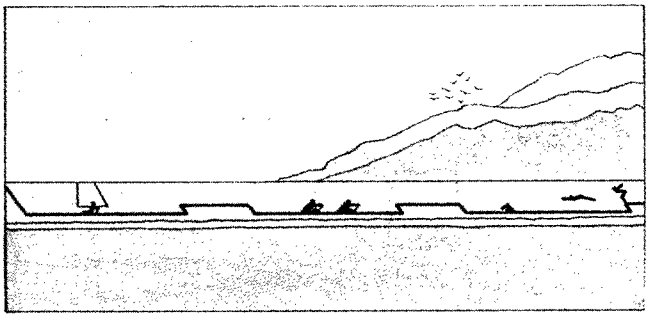
advantages. Bright, vivid colors tend to create a festive atmosphere; in malls, plazas and other public spaces, the use of contrasting colors helps to create visual interest, cheerfulness, and excitement. In such situations, the use of wall graphics can be both appropriate and attractive. Graphics can be used to convey a simple message or to identify a place with effective and pleasant results.

Proposed graphics: (State of Minnesota)



At an overpass

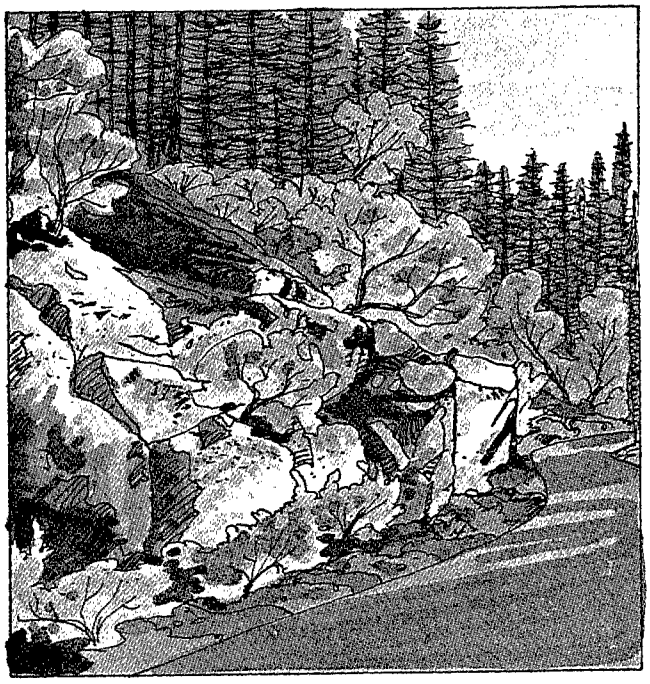




Adjacent to a beach recreation area

Color interest and variety may be achieved through the use of plant materials instead of by direct application on barriers. The added advantage of plantings is in seasonal variation of color. Plants which change color in spring, summer, and fall, when used in conjunction with a barrier, will impart a seasonal variation in the barrier as well. In most cases, the barrier should be of a neutral color which blends with the environment, rather than attracting attention.

Seasonal color provided by plant materials



Bold textures along a highway

Texture

Textural variations account for much of the visual interest in our daily lives. The use of texture on noise barriers helps to create a pleasant variety for both the motorist and the resident. The requirements of each are different, however, and must be treated differently for optimum results.

A motorist views a barrier at speeds of up to 55 mph and has little opportunity to examine details. Most details flash by in a blur.

To be effective, textures along the highway need to be bold or coarse and visible at a glance because the motorist's attention should not be diverted from the highway. Detailed textures require detailed examination, for which the motorist has no time. The resident, however, views the barrier at a much slower speed, and at closer distance. The pedestrian has the time to be interested in detail. Bold textures in this case become monotonous; the viewer concentrates on a small part of the scene rather than the entire composition. Textures should, therefore, be of a fine or detailed nature when the barrier is likely to be viewed by the pedestrian.

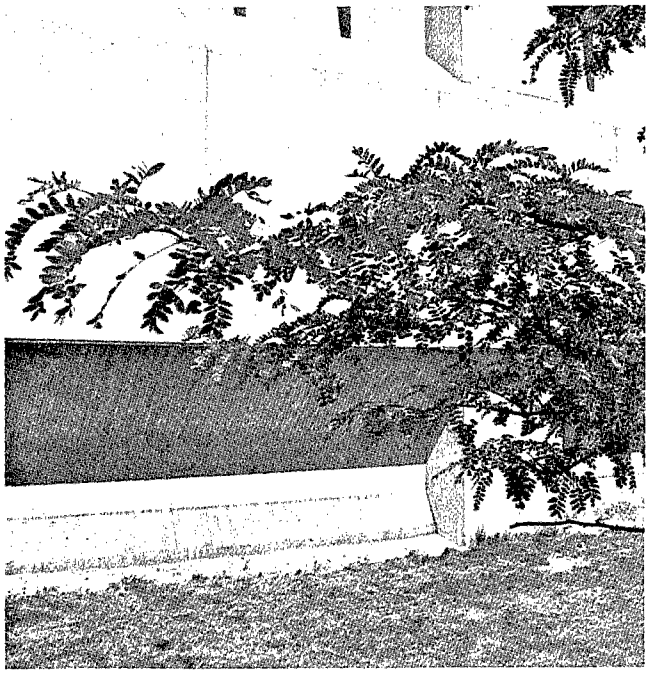
The textural detail of this paving is suitable for viewing at the pedestrian scale.

Creating Texture

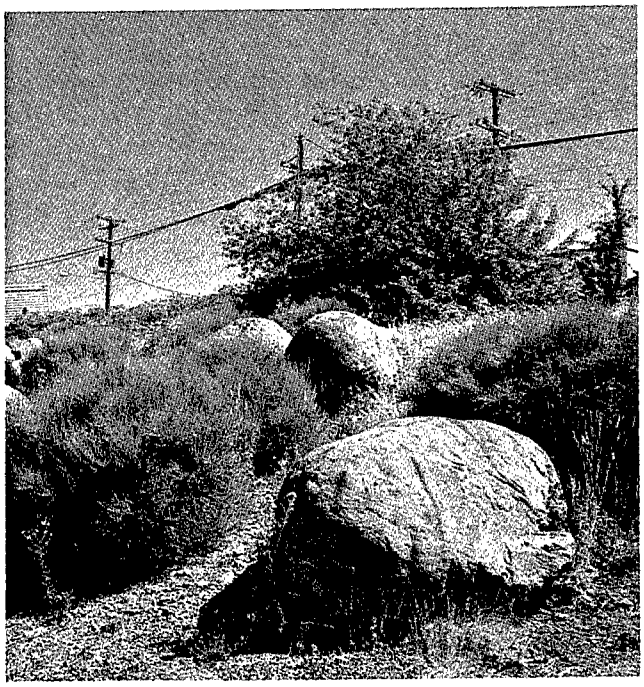
Each type of noise barrier presents the opportunity for textural variation, which will aid in public acceptance of the barrier. Textural variation in earth berms can, perhaps, be best accomplished through the use of plantings. Plantings on the highway side should be arranged in large groupings or masses of a single plant type, size, or color. Plants with large leaves represent the coarsest textures and should be used "en masse" where this texture is desired. Massing should be in irregular, free-form patterns of varying size, rather than equally spaced and repetitive. Patterns may be repeated, but should be large enough that the repetition is not obvious from a single viewpoint.

Berms adjacent to residential areas and pedestrian traffic should employ both fine and coarse texture to provide visual interest. Plant masses may be smaller; fine textured plants can be seen and appreciated by the pedestrian individually. Grass, the best natural ground cover, is a fine textured plant which provides a good balance when used with coarser trees and shrubs in a planting. Where possible, plantings on a berm should consist of native species commonly found in the area. Trees and shrubs on a berm, which are similar to adjacent plantings, will help to achieve continuity between the berm and the surrounding environment.

Coarse texture in plant materials



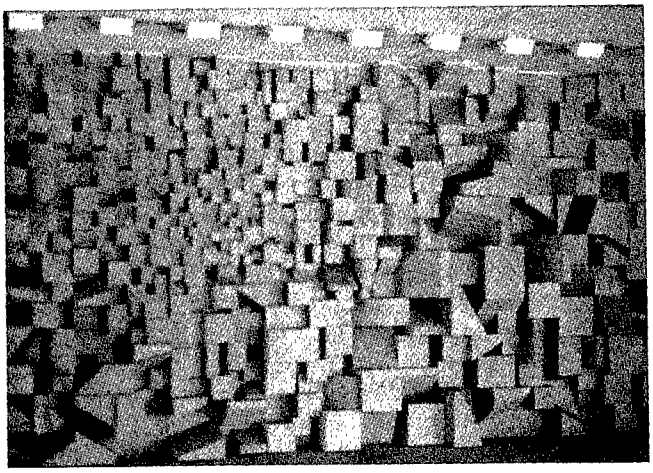
Fine texture in plant materials

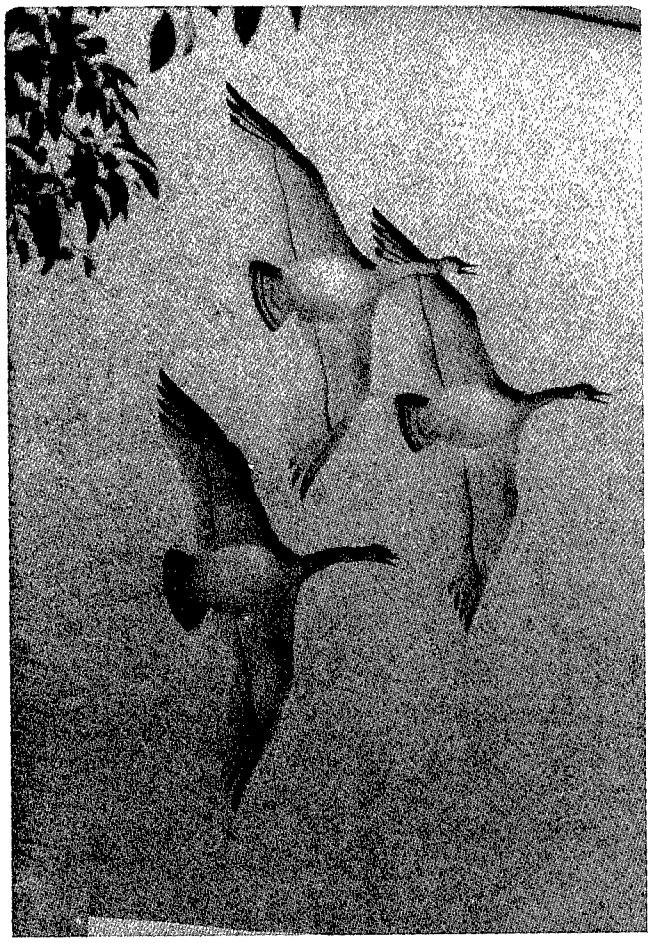


Coarse texture on a berm, created with rock and plant materials

Fine textured plant materials on a berm

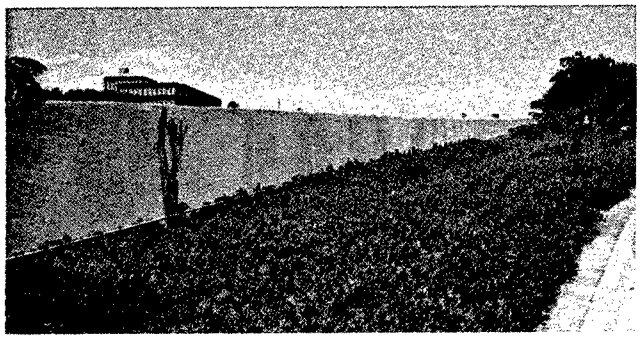
Rock and gravel may provide textural interest but should be used in combination with plantings to avoid the somewhat artificial look created by gravel alone. Gravel is relatively maintenance free and provides a good contrast when used with plantings, but it appears cold and stark without the balance of plant material. Large rocks provide good coarse textures for earth berms.



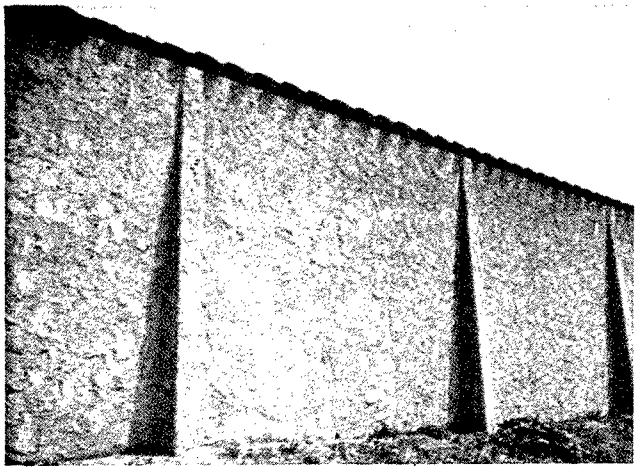


There are unlimited possibilities for achieving texture in concrete.

Fine textured stucco . . .



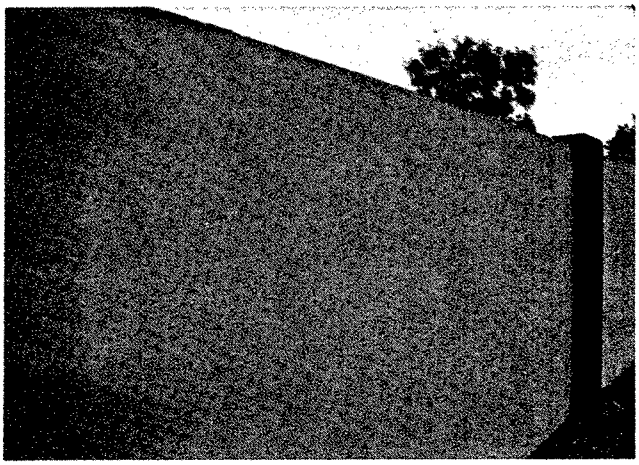
. . . cannot be distinguished, even at this relatively short distance.



Coarse texture in a stucco wall is visible at a distance.

Texture in Walls

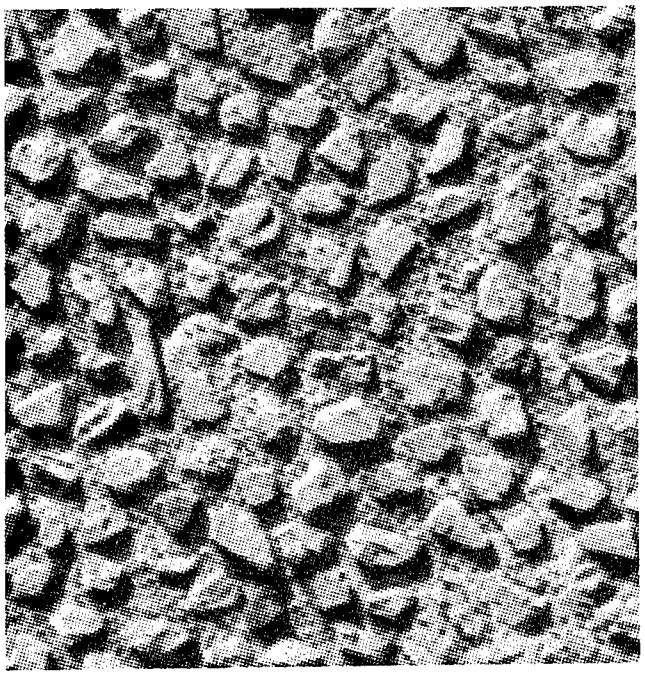
Walls present good opportunities for textural treatment. Texture should be used wherever possible for maximum visual potential. Cast-in-place and precast concrete has great flexibility for variations in surface texture. Texture may be created during the casting process or applied afterward. Stucco, primarily using a rough trowelled finish, has been used effectively for highway noise barriers. The possibilities for the use of stucco as a texture are quite varied, although the finish must be quite rough to be effective visually. The use of this material should be confined to localities where stucco is a common building material in order to ensure visual continuity.



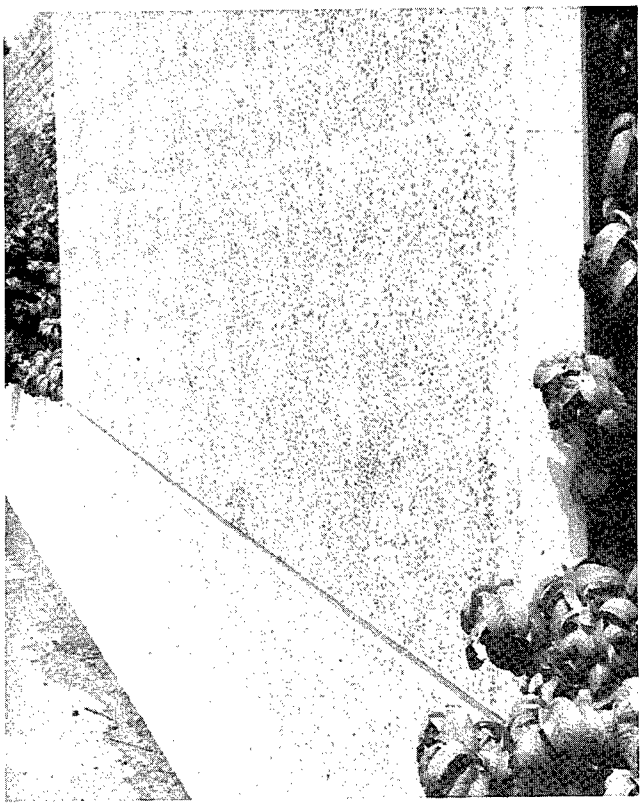
A fine textured broom finish is difficult to see at a distance.

Exposed aggregate finishes create interesting textures, particularly where coarse aggregate is used in the mix. This is also effective when used alternately with other textures. The added advantage of exposed aggregate is low light-reflectance which helps to reduce the visual impact of the barrier. Wall colors can be varied, depending on the color of the aggregate.

Shadows created in the forming process help to create texture and break up the visual monotony of a plain wall. These may be created through the use of rustication strips placed in the forms, or by variation in the form itself. Horizontal overhangs or vertical jogs in a wall should be deep enough to cast a discernable shadow visible from a distance.

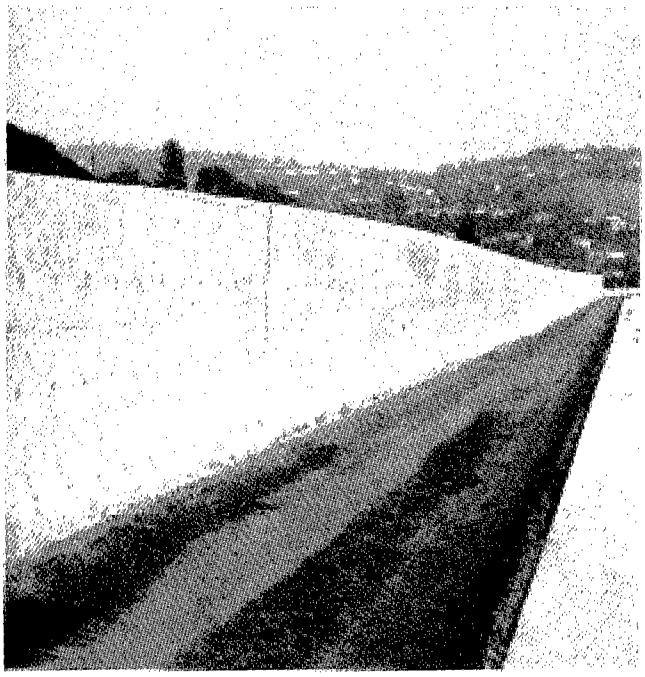


Exposed aggregate surface on a concrete wall



Exposed aggregate surface treatment carried through on New Jersey type barrier

Shadow lines created in the forming process

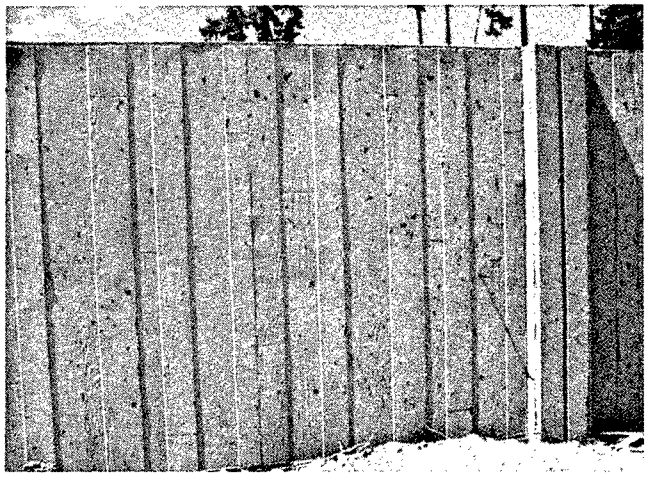


Without a visible texture, a wall appears plain and unattractive.

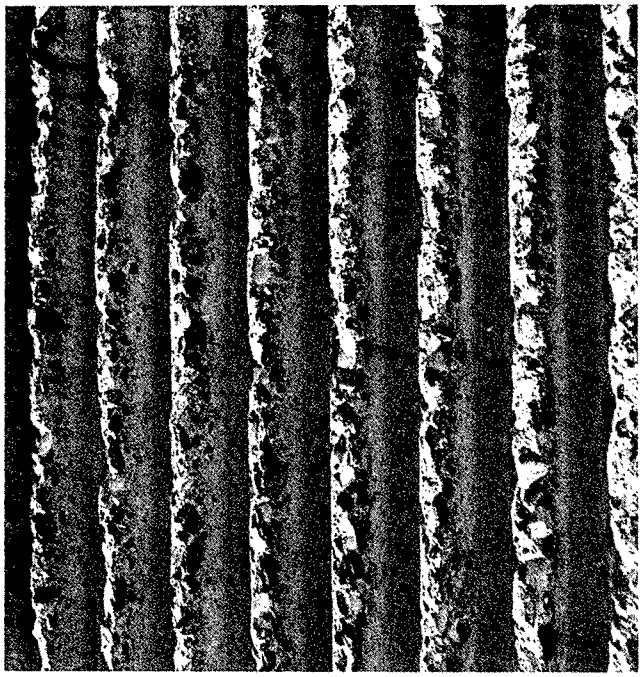
Board-form textures on a concrete wall create the look and visual appeal of wood. To be most effective, boards must be rough surfaced. By alternating boards of varying thicknesses, the effective viewing distance of this surface is increased due to the shadows created.

Form liners are available commercially in a variety of patterns. New patterns and liner materials are constantly being developed. Some liners are relatively expensive and may be used over and over while others can be used only once. The form liner is a highly effective method of creating texture in cast concrete, and the possibilities for textural variety are near endless. Almost any common type of building material, including wood and brick, may be simulated in cast concrete, a less expensive, more durable, and widely available material.

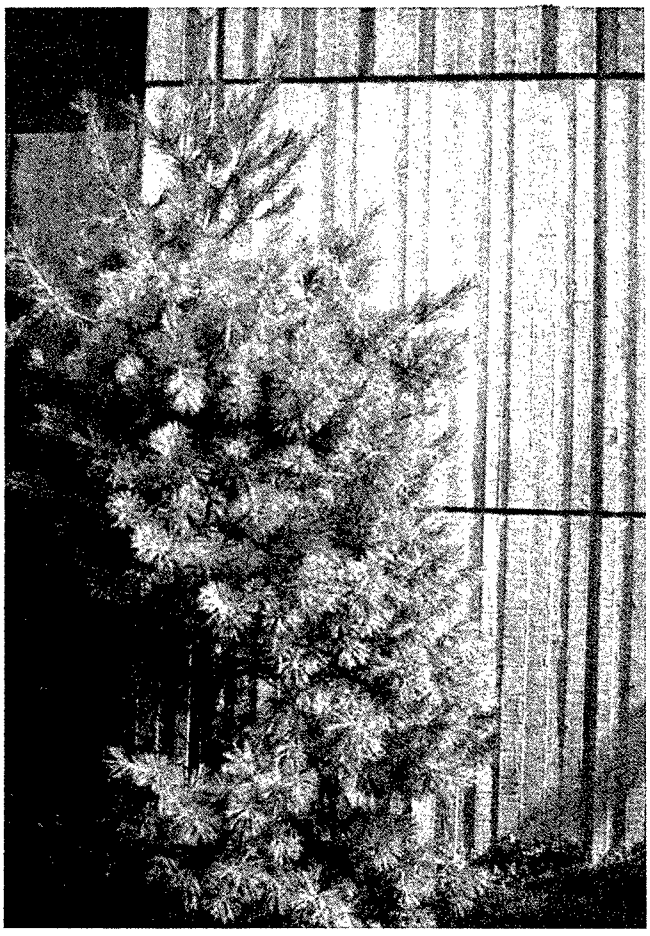
Perhaps the most visually effective method of creating texture in concrete is by utilizing a combination of methods and textures, particularly for long and high barrier walls. Interesting effects may be obtained by varying the texture of a long section of wall; however, textures should be compatible and similar in contrast. Rarely should more than two textures be used on the same wall; the designer should avoid alternating textures in even, repetitive patterns.



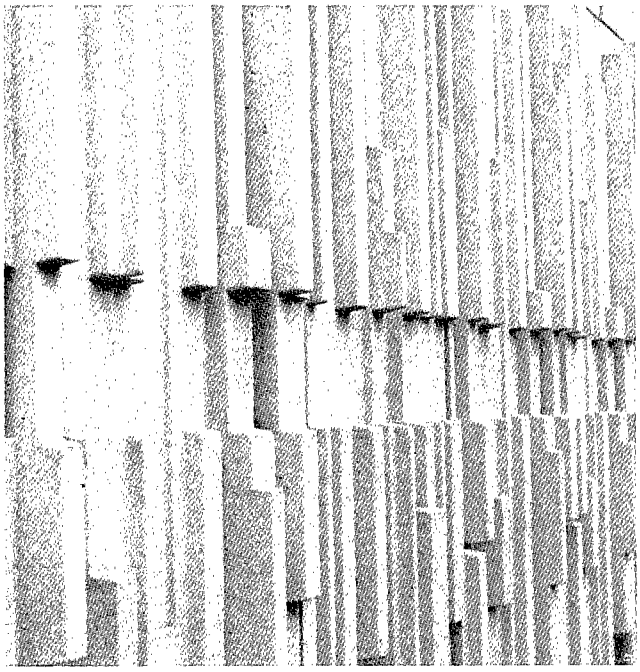
Board form texture on a noise wall



Textures created by form liners . . .

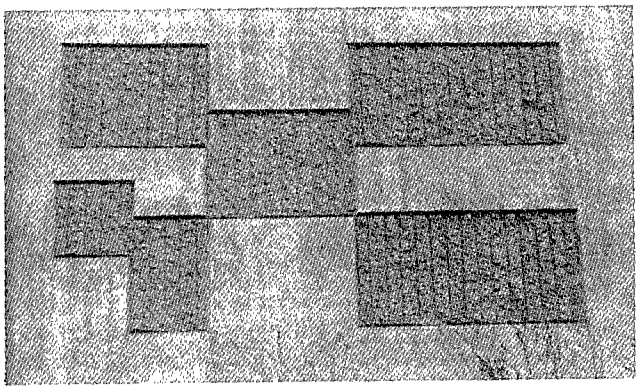


Board form texture and fine textured plant materials

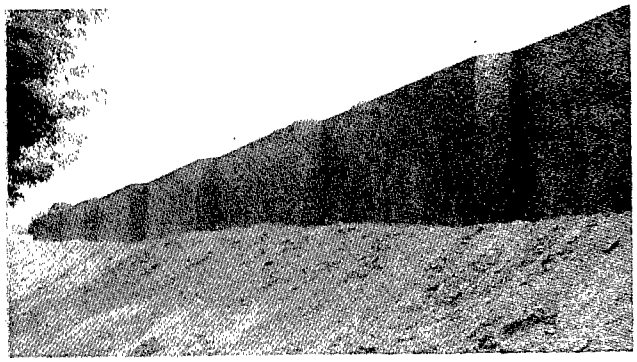


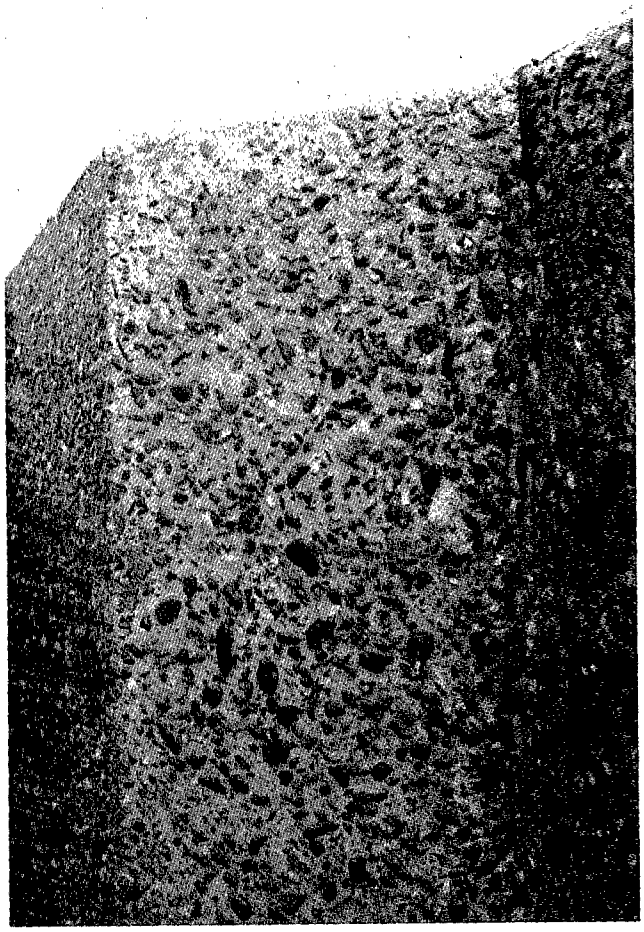
. . . used in the casting process

Texture in concrete and plant materials



Texture created with reinforcing rod used in the forming process

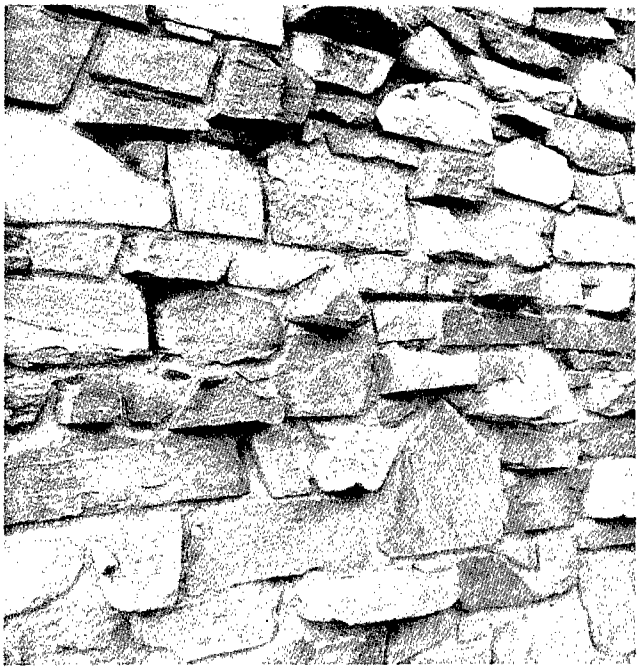




A combination barrier with an exposed aggregate surface treatment. The relatively fine texture is difficult to see at a distance.

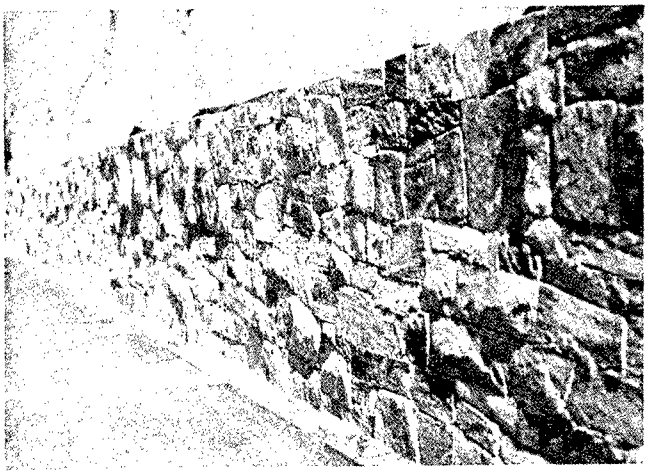
Texture in Combination Barriers

Combinations of berms and walls are effective for noise control, particularly where height requirements will not be reached by use of a berm alone. Textural interest may be created through treatment of the wall surface, through the use of plant materials on the berm, or both. The residential side of a barrier, when likely to be viewed by pedestrians, should incorporate both fine and coarse textured plant materials. Coarse textured plant materials should be ultilized on the highway side in mass plantings, alternating with fine textured grasses and ground covers for maximum effect. Plant masses should vary in height to further enhance the visual effect of the variation in textures. If a wall is placed on top of a berm, the viewing distance is increased, and textural treatment on the wall surface must be coarse in order to be seen by the motorist. Walls may also be used to retain earth berms; texture in this case is an important consideration since the wall is placed closer to the viewer. Often New Jersey type barriers are used as retaining walls for earth berms; these may be textured through sand-blasting or by creating an exposed aggregate finish in the forming process.

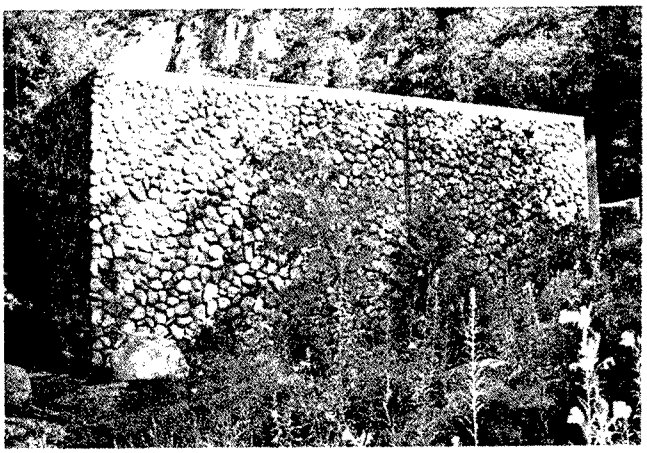


Mortared stone

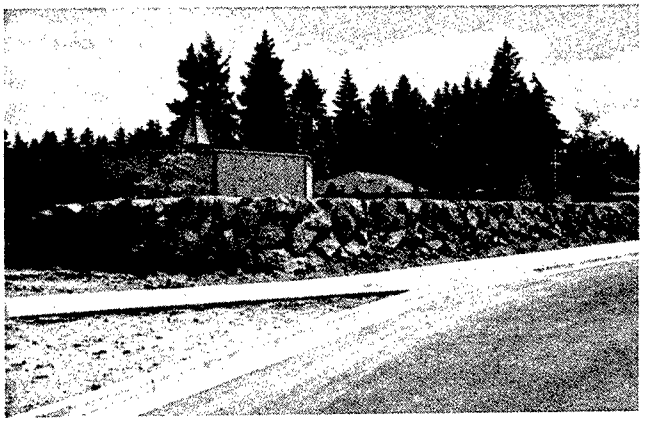
Broken concrete used as a retaining wall



A coarse textured stone wall.



Natural texture helps to blend a structure into the environment.

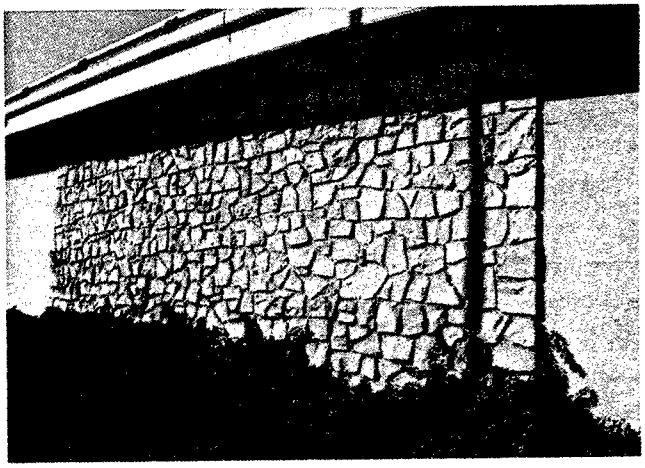


Dry stone used in combination with a berm for noise abatement

Creating Texture—Other Materials

Noise walls have been constructed of a variety of materials in addition to cast-in-place concrete. The following materials may be used successfully to create texture, and thereby increase visual quality in noise barriers.

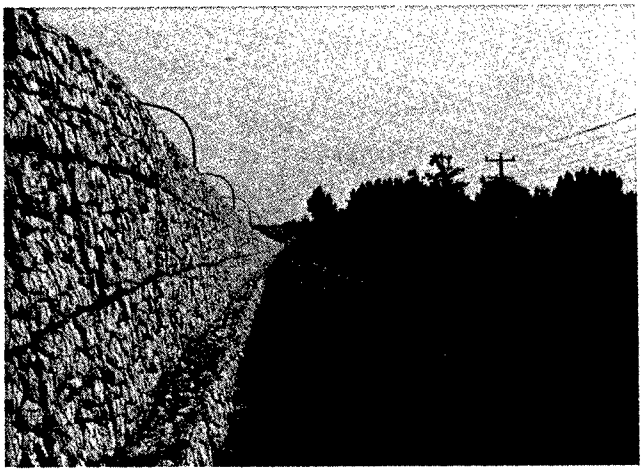
Stone exhibits a naturally rough, coarse texture. Visual interest may be created by the use of stone applied as a facing material to concrete or concrete block walls. Stone is particularly effective when the mortar joints are deeply raked to produce a three-dimensional look, due to the shadows which result from this method. Stone has also been successfully used as a dry wall and may be constructed as a free-standing wall or as a retaining wall for earth berms. This method is useful where right-of-way is at a minimum, and available space limitations prevent the use of an earth berm alone. The natural appearance of stone blends well with the highway environment and with the rural and semirural landscape. Where this material is readily available, consideration should be given to its use. Broken concrete from roadway excavation has been used successfully for retaining walls and is an inexpensive, available material which resembles natural stone. The added advantage of stone is in the variations of color that are possible through the use of different types of stone. Rough stone is low in light-reflectance and tends to change in apparent color with the time of day, adding to its visual interest.



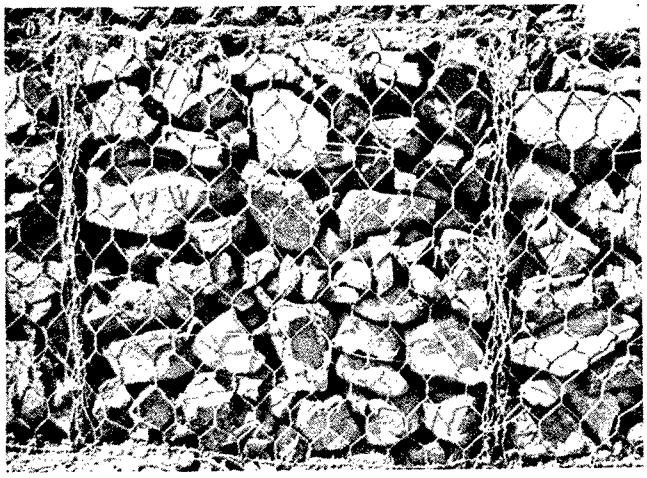
Variations in color of stone produce interesting visual effects.

Gabions, essentially wire baskets filled with stone, have been used for noise walls in Canada and are well received by residents, who like their natural appearance. The gabions may be stacked in various ways to create a wall. When viewed from a distance, the wire cage tends to become invisible, and the natural texture of the rock becomes dominant. Color variations may be created through the use of different colored rock, depending on local availability. Gabions also have proven to be relatively maintenance free and extremely durable.

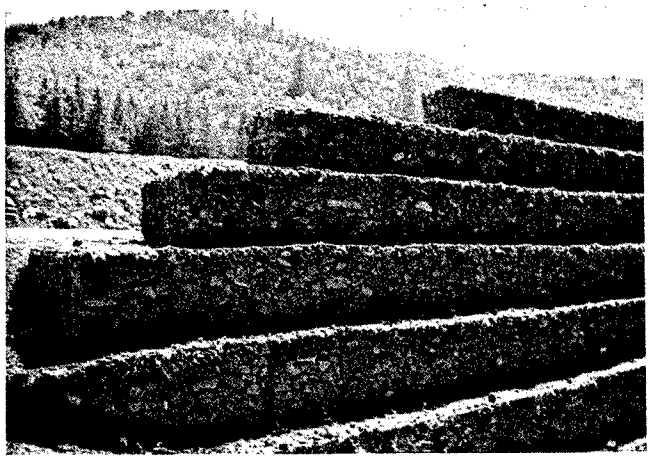
A gabion noise wall



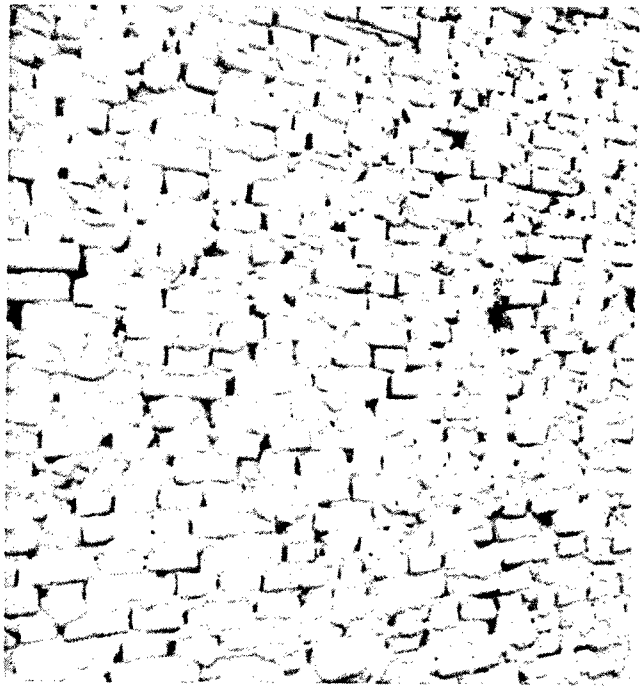
Note how color of wall changes with time of day.



Gabions are essentially wire baskets filled with stone.



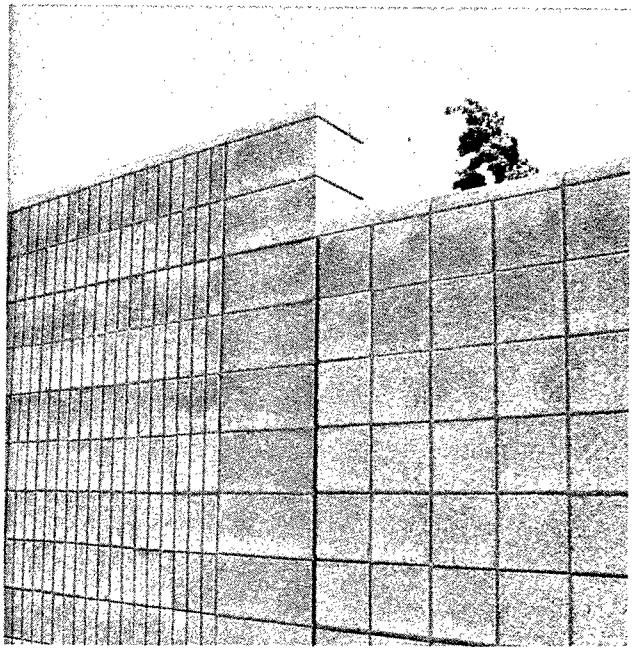
Gabions may be stacked in a variety of ways to construct a wall.



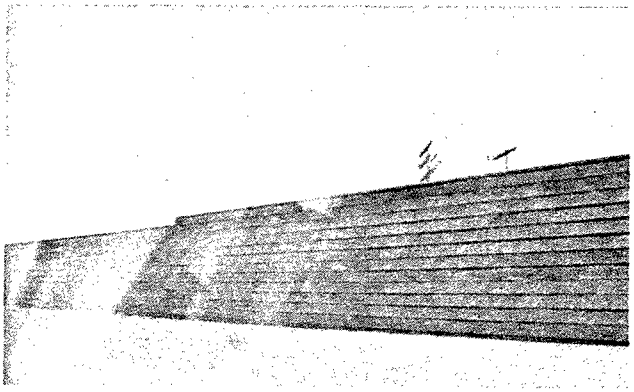
Unusual texture in a brick wall

A suitable distance from which to appreciate texture in brick

Brick may be used for noise walls, although the detail of the bonding pattern is fine textured and is, therefore, best viewed at close distance. The fine texture of brick is indistinguishable by a motorist moving at a high rate of speed. Therefore, for highway use, texture should be created through other means, such as with plant materials, particularly on the highway side of the wall. Deeply raked joints help to create shadows which increase the effective viewing distance of brick. Textural shadows may also be created by offsetting bricks in random patterns, or by the use of pilasters, copings, or other variations in the line of the wall.

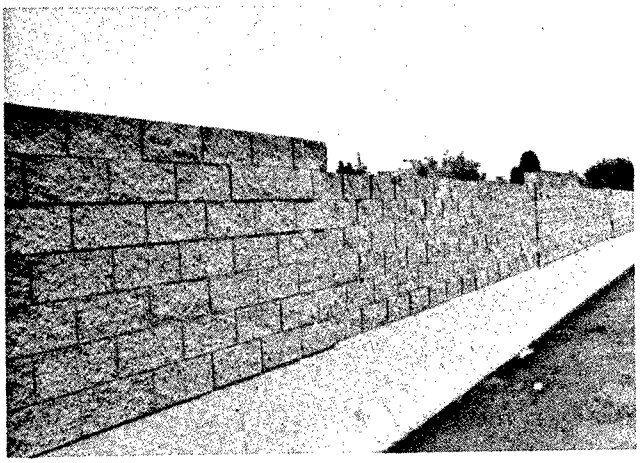


This finely detailed pattern . . .

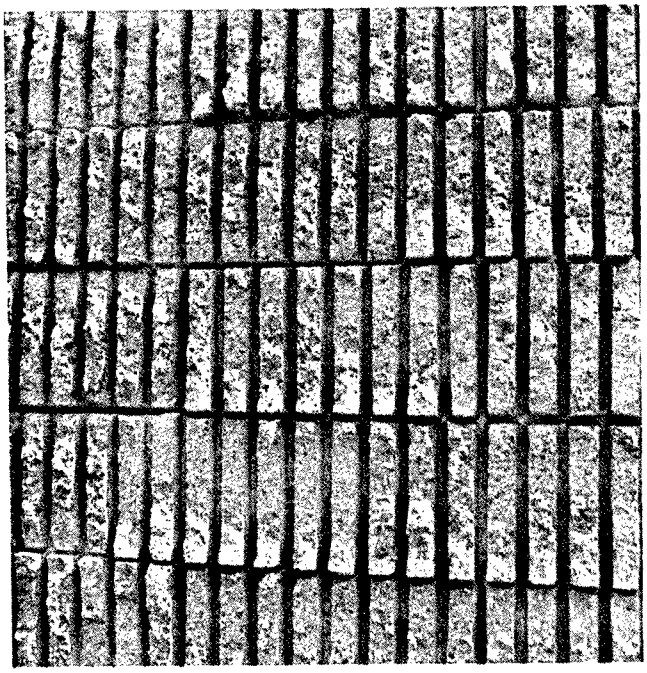


. . . means nothing to a motorist passing by at a high speed.

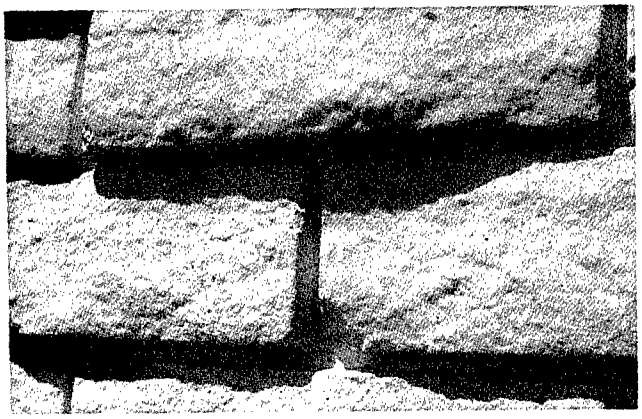
Concrete block is available in a variety of textures. Split-face block is particularly useful for noise walls, since the rough surface texture resembles stone and is visually attractive. Slump blocks also provide a rough surface texture visible from a distance. Standard or split-face blocks may be offset to form shadows. Blocks of varying thicknesses may also be used for this effect. A rough texture can be achieved with split blocks by using the jagged edge as a surface. Scored blocks with recessed grooves create interesting shadow effects which read as coarse texture. Each of these blocks may be specified in a variety of colors. The darker grays and browns more closely resemble other colors in the environment and tend to blend well when used in noise walls.

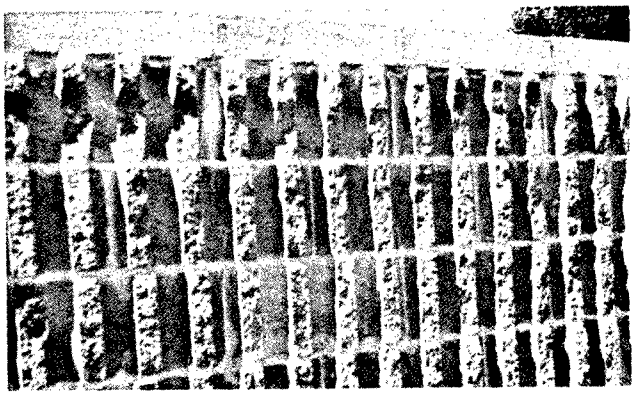


Split faced concrete block used in a noise wall

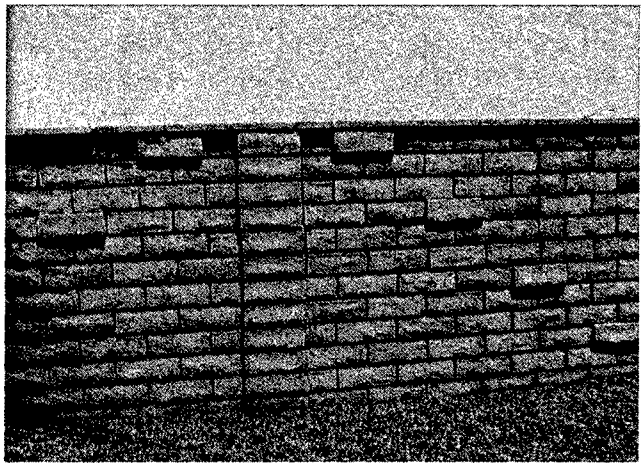


Scored concrete block

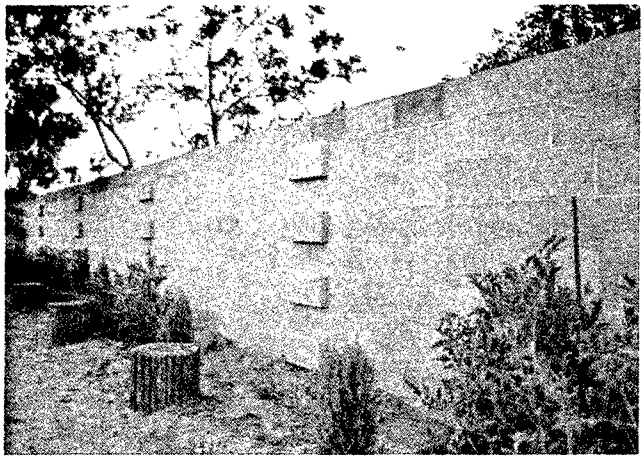




Textured blocks create shadow effects.

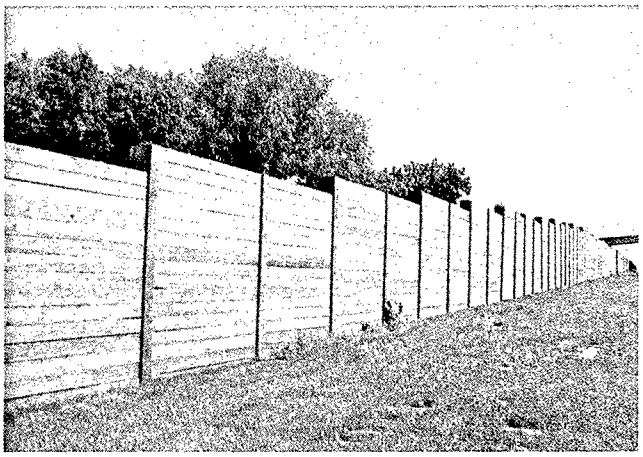


Slump blocks offset to create shadows.

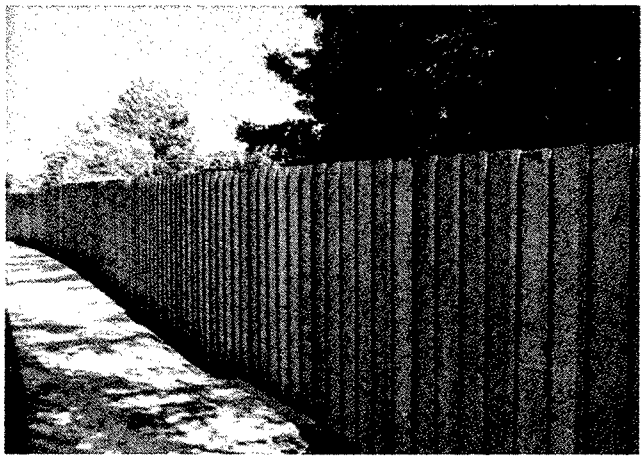


Concrete blocks of varying thickness to create shadows

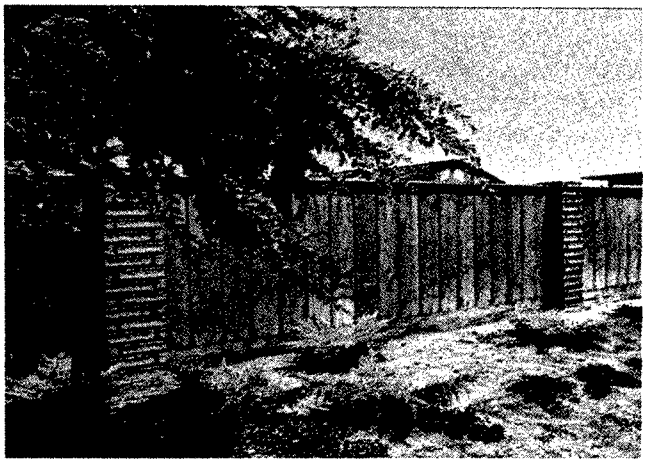
Wood exhibits a natural surface texture when rough sawn. Alternating thickness of planks placed either vertically or horizontally helps to make the wood texture visible at greater distance. Plywood has been used in several noise walls and is quite durable when treated properly. Rough sawn plywood paneling is attractive, but it is also relatively fine textured. The texture of wood is best viewed at close range; therefore, wood battens or other means to create shadows are necessary on a wood wall which is to be viewed from the highway or from a distance on the residential side.



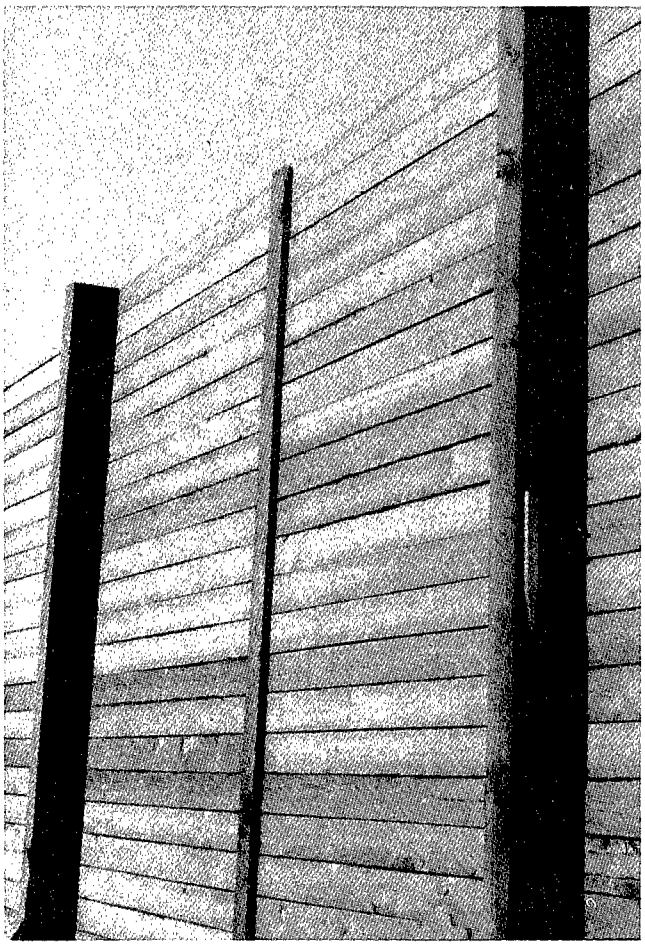
The natural texture of wood is difficult to see at a distance.

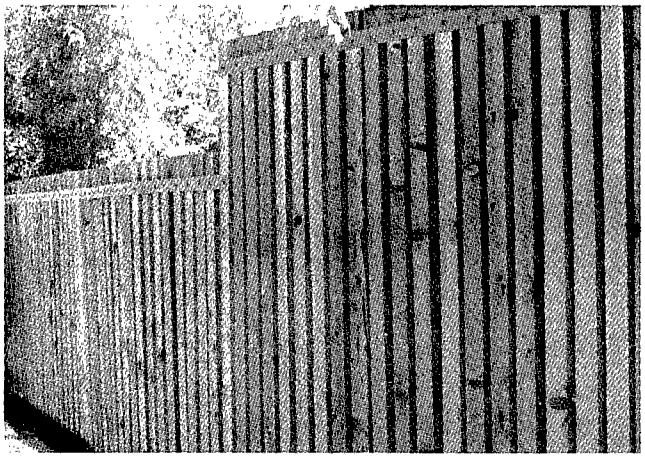


Wood battens used to create texture in a wooden wall

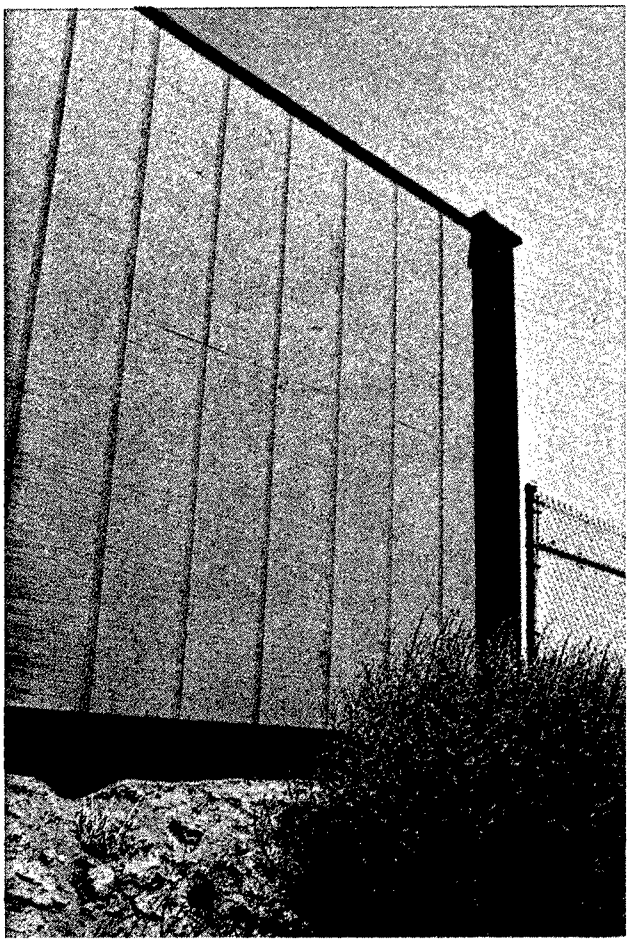


Natural texture of wood used in combination with concrete block

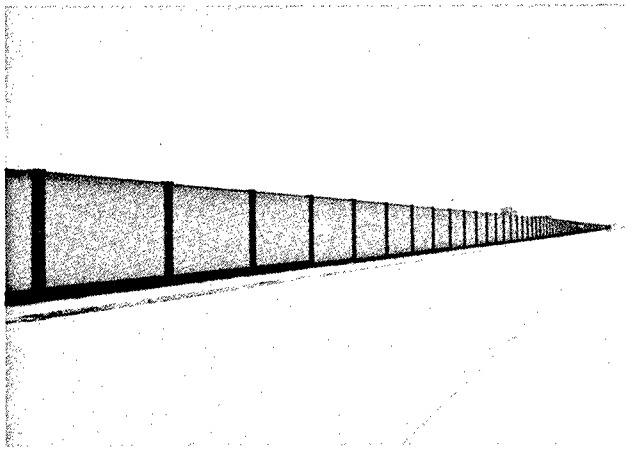




Shadows created by vertical posts increase texture.

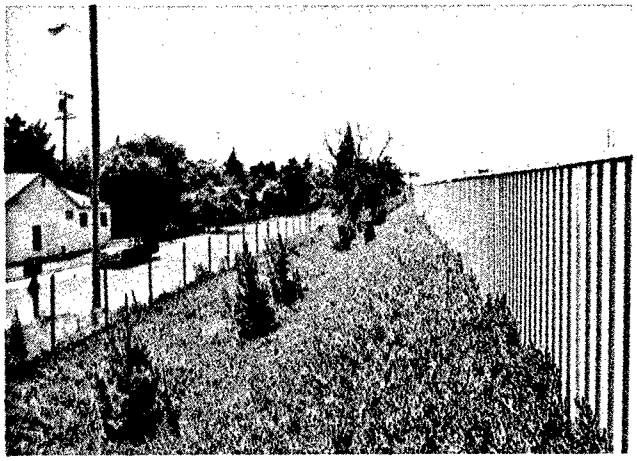


The rough sawn texture of this plywood panel . . .

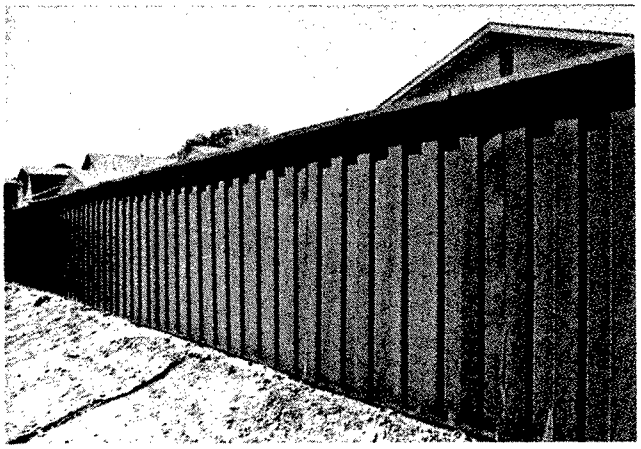


. . . cannot be seen at a distance.

Texture in metal walls is created by the corrugation of the metal sheets; many of these resemble wood from a distance. This effect may be heightened through the use of natural wood colors for metal walls. Shadows, created through the use of copings, offsets, etc., help to provide textural interest to otherwise plain walls.

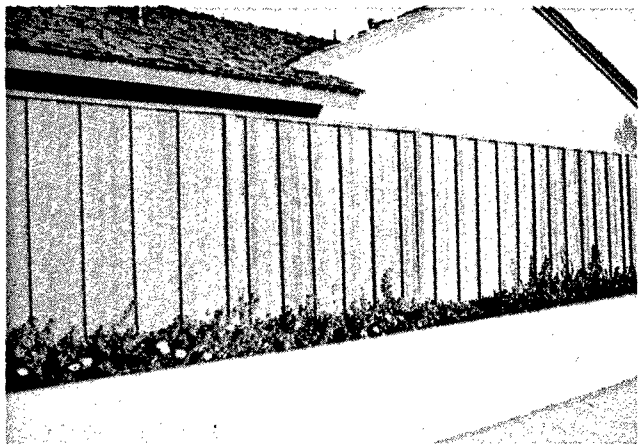


A textured steel corrugated wall which resembles wood

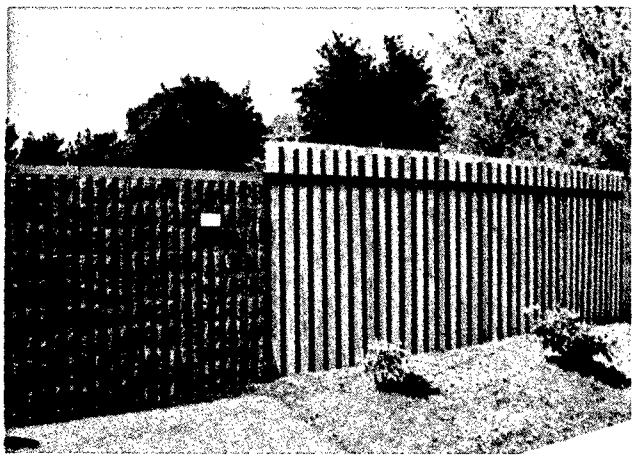


A Corten steel corrugated wall which rusts to a natural wood color

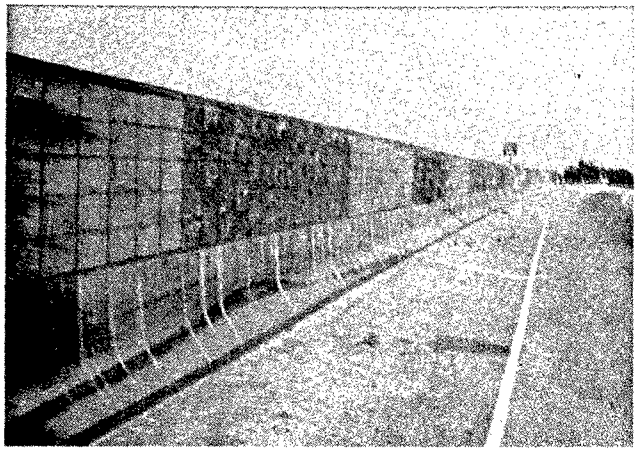
Combinations of materials may provide textural interest. Concrete blocks of different surface textures may be alternated although care must be taken to avoid an obvious repetitive pattern. Wood and concrete may also be alternated to create an interesting wall design. A conscious design effort is needed in order to avoid the checkerboard effect of alternating patterns of texture on a wall. Textural variation is best accomplished at some point of change in wall height or configuration. Arbitrary changes in texture along a straight wall appear to be without purpose and tend to detract from the appearance of the wall.



Combination wood and concrete wall. Note similarity between wall colors and house colors.

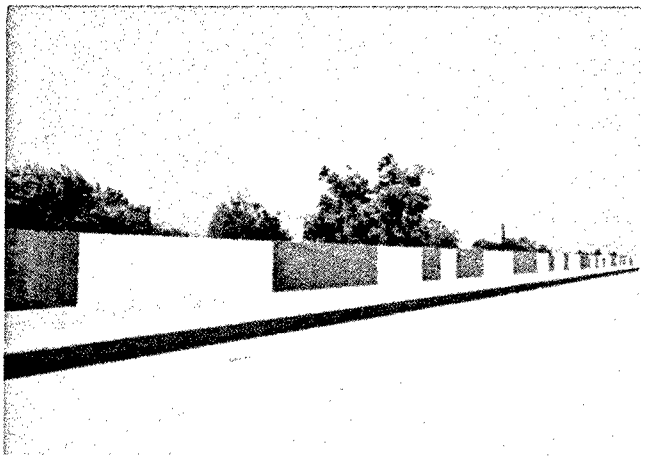


A combination of materials which produces an interesting wall



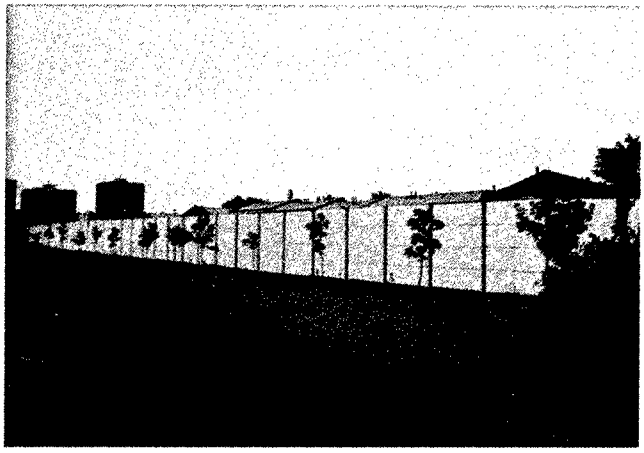
Coordinate Elements and the Noise Barrier

Undesirable contrast . . .



Between adjacent colors

Between wall and surroundings



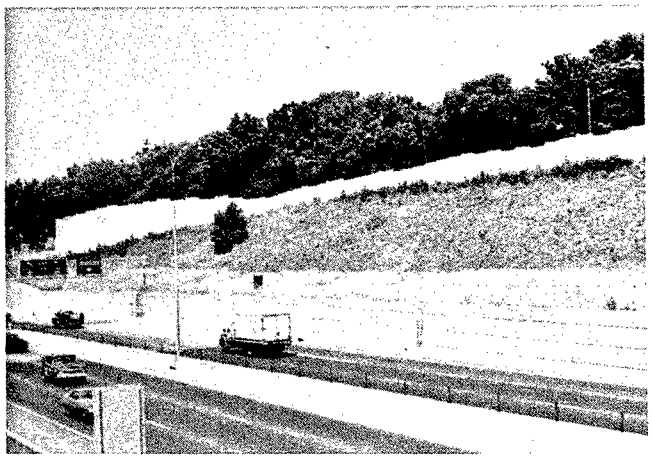
Avoid repetitive, equally spaced tree plantings.

Contrast

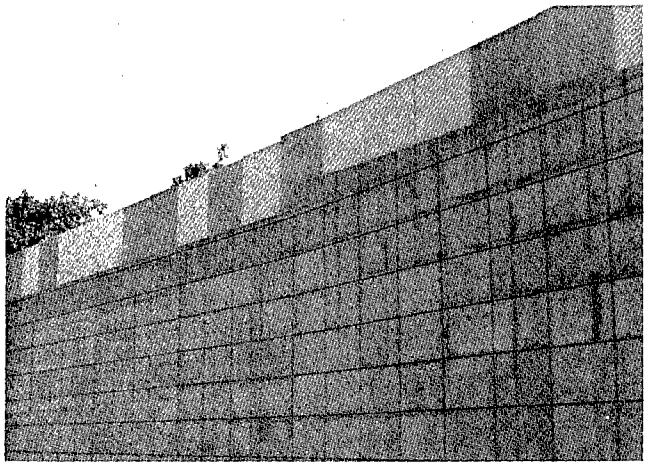
A noise barrier may contrast with its surroundings by its line, form, texture, or color. In an urban setting, adjacent to pedestrian traffic, a higher degree of contrast may be appropriate, particularly where a festive, active human activity is desired or exists. In residential areas, the barrier should be unobtrusive and, therefore, low in contrast. On the highway side, a barrier should blend rather than contrast with the surroundings since high contrast is distracting to the driver. Plantings can either increase or decrease contrast of a noise barrier. Plantings that are similar in form, color and texture to other native plants present in the area help to reduce the contrast of a noise barrier. Plantings that are unique in form or color or that are dissimilar to native plants in an area tend to increase contrast. Likewise, to decrease contrast, plantings should be arranged in informal, natural groupings rather than in obvious, equally spaced, patterns.

Contrast may also be increased or decreased via color of the barrier itself. Where high contrast is desired, lighter colors or wall graphics may be used effectively. Darker, earth colors tend to reduce contrast. *The designer should examine the site and surroundings in order to determine the predominant natural colors and choose similar or harmonious colors for the noise barrier where low contrast is desired.*

A noise barrier which is low in contrast and seems to blend with its surroundings



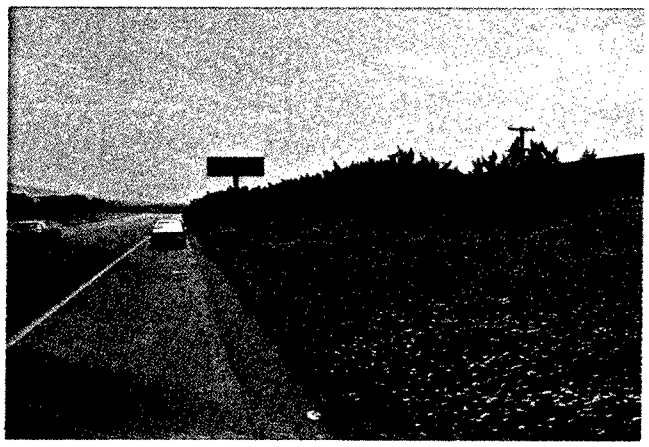
Excessive contrast. A darker color would blend this barrier into the background trees.



High contrast between adjacent materials

Sequence

Travel on a highway is a continuous, ever-changing experience of vision and motion. A planned sequence of events creates interest for the moving observer; a static event creates monotony. A noise barrier can create a pleasant visual experience for the motorist through a progression or planned sequence. The transition from ground plane to maximum barrier height should be a sequence of gradually increasing steps or a continuous sweeping line to help create this effect. A sequential experience may be created through the arrangemnt of plantings, by a gradual increase in height of trees and shrubs. Plant masses can be used to define a space by becoming, in effect, the walls of the enclosure. Varying the position of these masses with respect to the road creates a succession of confined and relatively open spaces. This pleasant feeling of motion and rhythm imparted to the moving observer tends to dramatize the experience of passing through the space. A planned sequence can be a pleasurable experience for the pedestrian also, but it must be designed at a scale consistent with the slow viewing speed of the observer. Individual enclosed spaces of an intimate scale can be created for pedestrian interest and enjoyment through integration of walks, noise barriers, and plant materials. The pedestrian or motorist should be confronted with a series of different spaces (each designed to be separate, yet interconnected) as he or she moves through the entire composition. In this way, the observer experiences the individual spaces but also is aware of his or her progressive movement from one to the other.



Plantings on a berm, used to open and enclose the visual space along a highway and help create a pleasurable sequential experience for the motorist

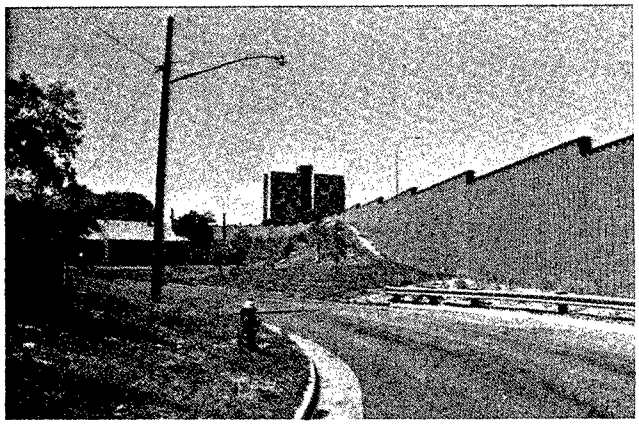
Axis

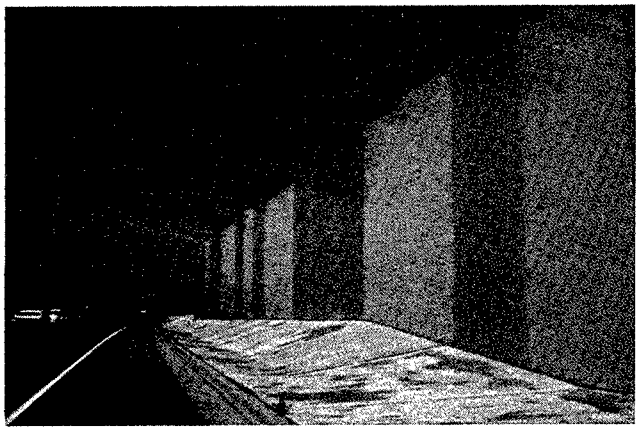
The highway is often a strong visual axis which tends to direct the view forward in a straight line. A noise barrier of substantial length tends to reinforce this axial view, as an element of enclosure and enframement. However when a high barrier is placed on only one side of a highway axis, a visual imbalance exists which is distracting to the motorist. The visual axis should be balanced in some way on both sides of the central element. Visual balance may be achieved by similar elements on either side or by dissimilar elements of equal dominance. A grouping of trees can effectively balance an axial view if placed opposite a noise barrier in an asymmetrical manner. Tree groupings can suggest an axial balance without actually forming or continuing a distinct line. This completes the enframement of the highway scene and directs the eye forward, away from distracting elements.

Tree masses on each side of the highway effectively balance the axial view in an asymmetrical manner.

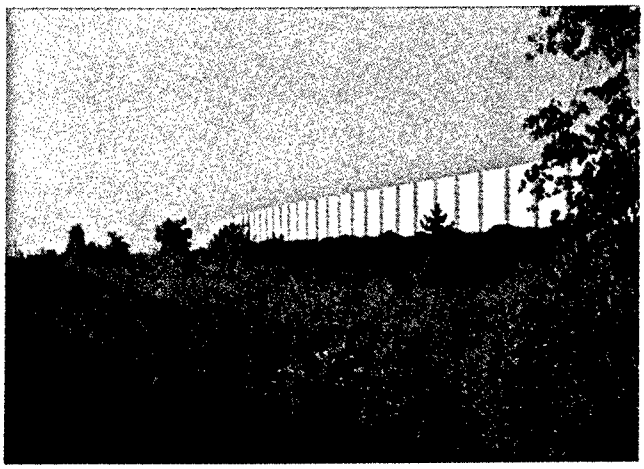
Dominance

A dominant element attracts attention to itself in a visual scene. A noise barrier should not be the dominant feature along a highway. Single dominance can be reduced through the introduction of other dominant elements which balance each other in the visual composition. Plantings in front of a barrier help to reduce visual dominance, particularly if the plantings are native varieties commonly found or present in an area. Color can also affect dominance. Brighter, contrasting colors make an object more dominant. Subdued, harmonious colors, similar to surrounding colors in intensity, tend to make an object less dominant. Wall design can also affect dominance of a noise barrier. Straight, high walls adjacent to the roadway appear imposing, an encroachment upon the space. Walls which step back in some way relieve this tight constricted feeling, and become less of a dominant element in the highway environment. Similar patterns of dominance occur on the residential side of barriers, with equally similar effects upon the resident.

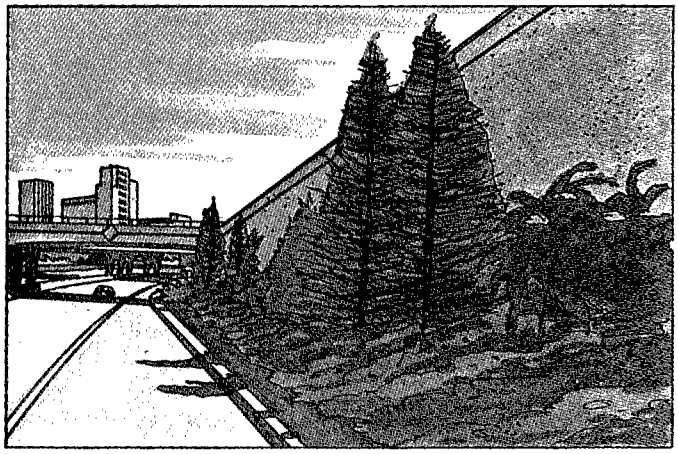




Dominant noise barriers



Bright colors tend to reflect light, and become more dominant.



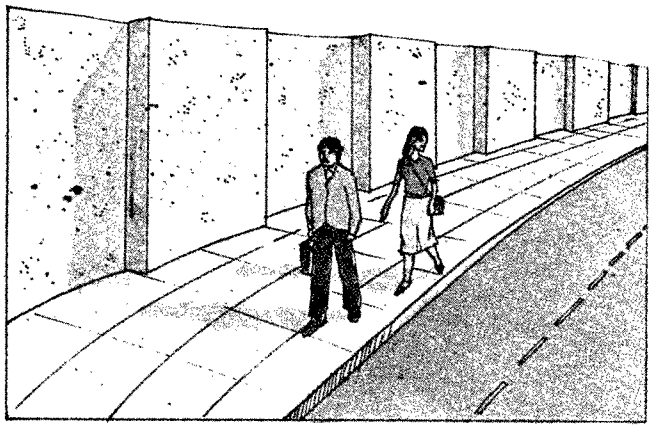
Plantings arranged in an informal manner to help to reduce the dominance of this wall.

Variable Elements and the Noise Barrier

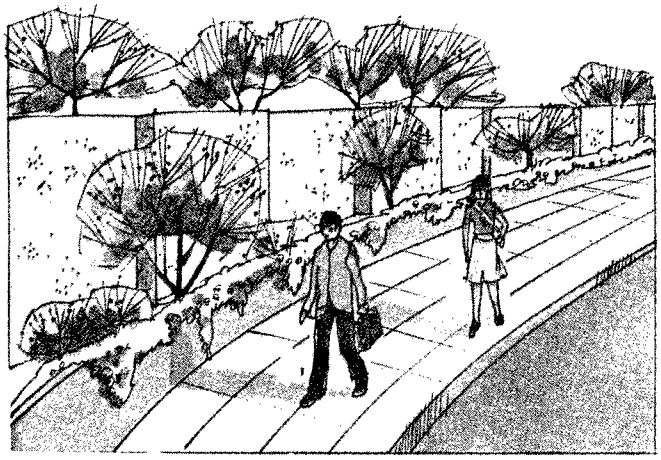
Scale, Proportion, and Distance

The scale of a noise barrier should relate to the scale of the highway and the scale of the neighborhood into which it is placed. Scale relationships differ on each side of the barrier and must be treated independently. The highway scene is large scale—the view is often panoramic, one of open space, composed of both distant and close-up forms. Objects which register on this large scale panorama are bold, massive, and distinctive in line, form, color or texture. The noise barrier, as part of this large scale highway scene, should incorporate bold, massive elements in order to be consistent with the scale of the surrounding environment.

The pedestrian side of a barrier presents a different set of scale relationships. The pedestrian sees a barrier from a different perspective, not as part of a panoramic view, but often as the major dominant element of a small, confined scene. As such, the barrier appears exceptionally massive and overpowering. To reduce this impact, barrier elements must be of a more intimate, human scale. Textures, in particular, should be finer, detailed, and varied. Large masses cannot be appreciated by the observer unless viewed from a distance—pedestrians tend to concentrate on individual details rather than an entire composition. From the highway, details are lost to the moving observer—the view is composed of contrasting masses and spaces with less regard for individual components of the scene. As viewing distance increases, scale relationships change, which necessitates a corresponding change in the design treatment of structures in the landscape.



The scale of this wall tends to be overpowering to humans.

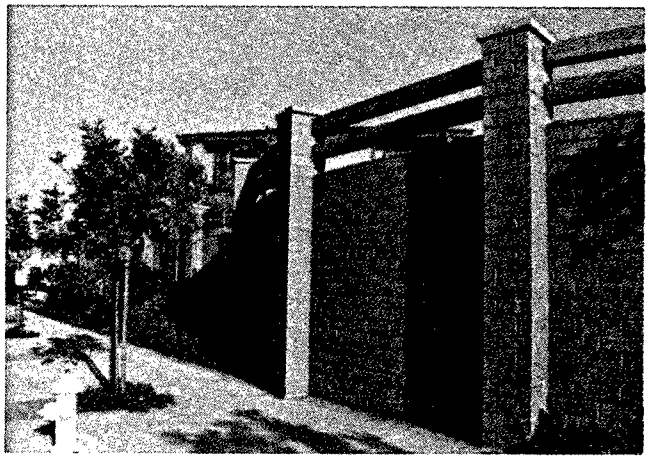


The scale of this wall relates better to pedestrians.

Details are lost to the moving observer.

Details which can be appreciated by the pedestrian.

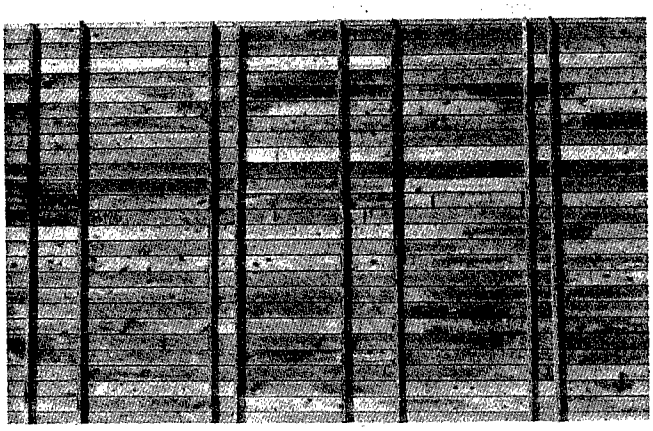
The height and length of noise barriers is dictated by acoustical and site requirements. However, the proportions of the component parts may vary in order to achieve visual balance. The "golden section", a theorem developed by Pythagoras, involves the division of a line into two parts of which the first is to the second as the second is to the whole. This roughly translates to the ratios of 3:5 or 5:8. Spaces or masses proportioned by these ratios appear balanced and harmonious. These ratios may be applied to noise barriers in terms of wall setbacks, multiple wall height ratios, and in stepdown of walls for grade changes or termination. Similarly, the proportions of alternating wall panels or other height-length ratios should follow this relationship where possible. The dimensions of vertical elements, such as pilasters, should be balanced and in proportion to each other when used in combination with horizontal segments of a wall.



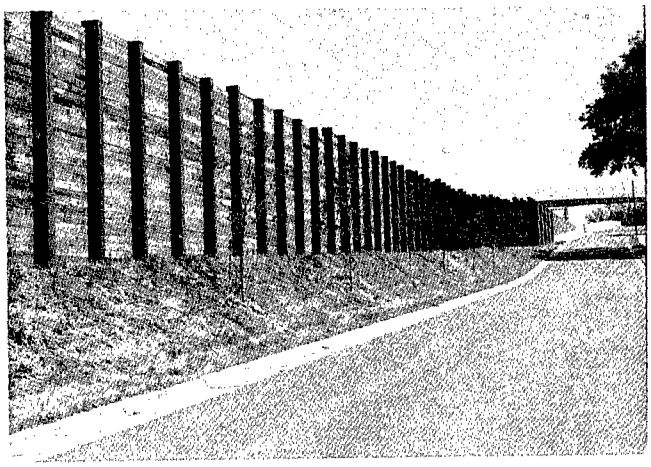
Good proportional relationships between vertical pilasters and horizontal elements in a wall

Observer Position

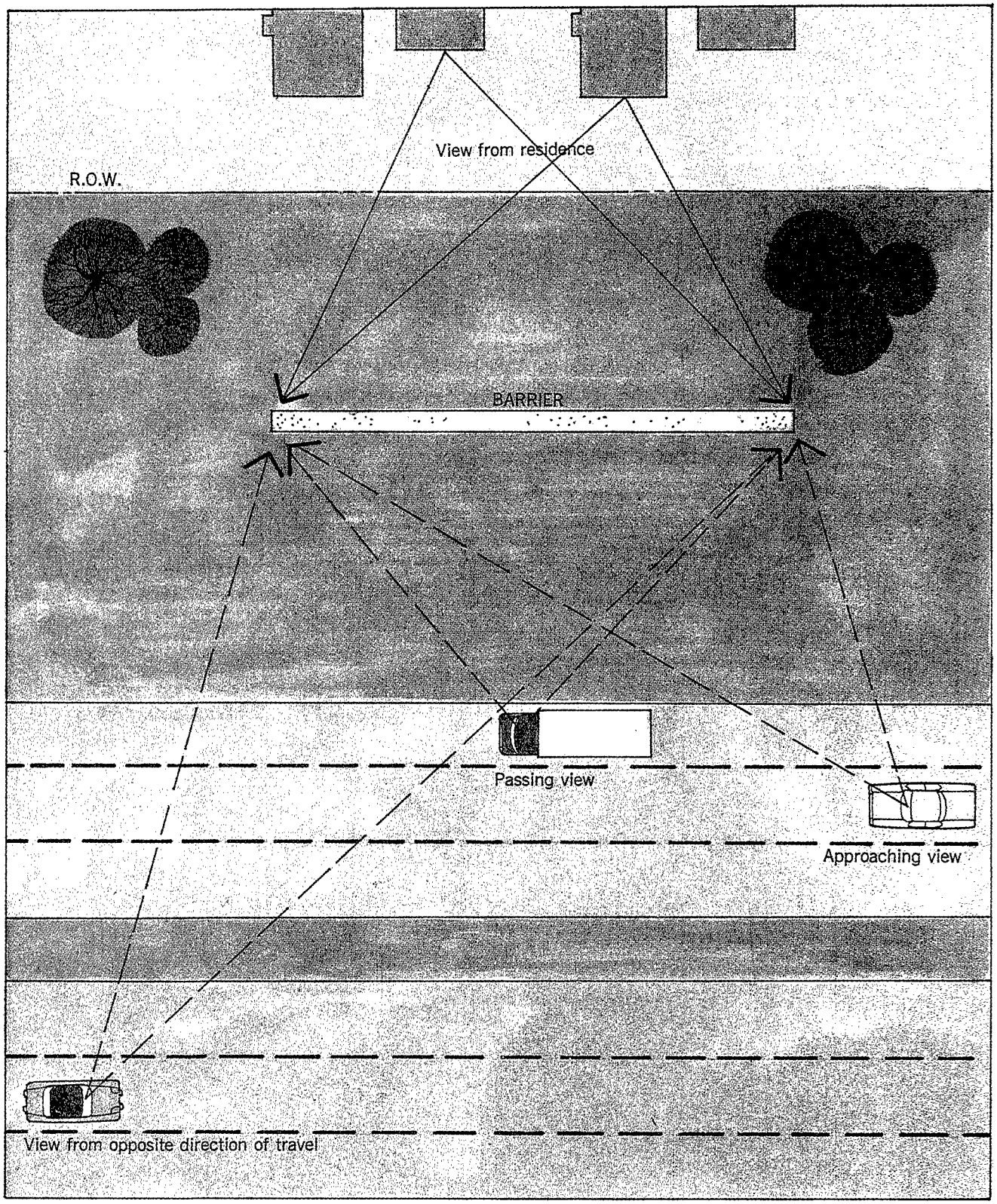
The position of the observer determines how much of a barrier is in view and the extent to which the barrier relates to other environmental components. A barrier is most likely to be negative in visual impact when the observer is relatively low compared to the top of the barrier. In this position, the barrier is most dominant, often blocking the view entirely. The viewing height from an automobile is approximately four feet (120 cm) above the pavement. The pedestrian eye level is approximately 5½ feet (170 cm) above the ground surface. From a moving perspective, a motorist has a minimum opportunity to observe design detail in elevation. A barrier is also viewed from two directions of travel on a highway and may appear different from each direction. The resident is more likely to view a barrier in elevation from a near perpendicular position, with consequent attention to detail. Consideration should be given, then, to the design of a highway noise barrier as it will appear in perspective, with the resultant effects of foreshortening, not just as it will appear in elevation. A proposed barrier should be examined at the position from which it will be viewed to determine if the desired visual effect will be achieved.



View of barrier in elevation

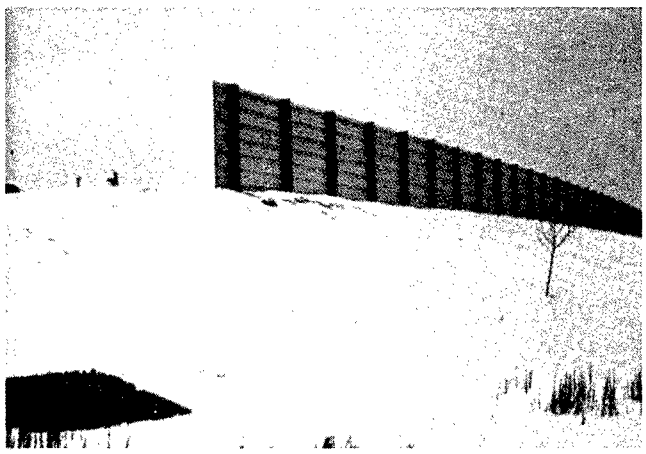


View of barrier in perspective. Note foreshortening effects: verticals seem to blend into a solid dark mass.


View from residence
R.O.W.
BARRIER
Passing view
Approaching view
View from opposite direction of travel

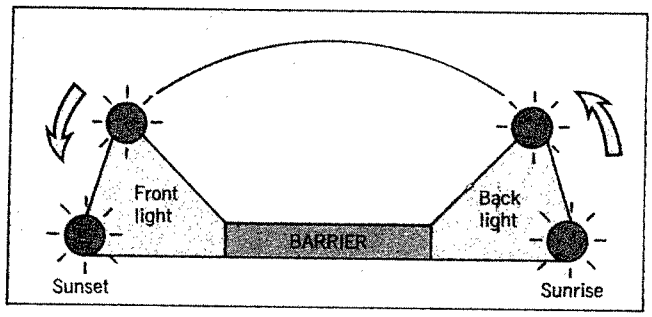
Atmospheric Conditions and Seasonal Change

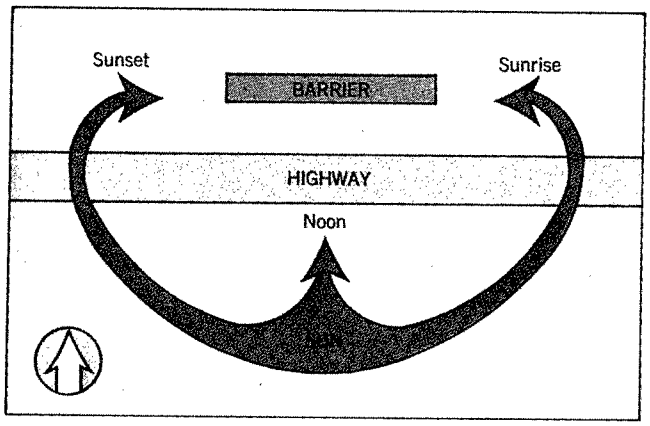
Atmospheric conditions may affect the visual impact of a noise barrier. Clear weather conditions promote maximum visibility and maximum contrast of colors. Precipitation in the form of rain, snow and fog reduce the effective viewing distance of an object and, therefore, the visual impact. A blanket of snow tends to obliterate or minimize horizontal forms in the environment and maximize the form of the vertical. A noise barrier is likely to have a high visual impact under this condition, particularly if it contrasts in color with the whites or grays of winter. In an area where snow covers the ground for a substantial portion of the year, the best color for a noise barrier might be a light gray in order to minimize contrast between it and the surroundings. The form of a noise barrier is likely to be most visible during the winter season when trees are bare and color in the landscape is at a minimum. A barrier may create unique visual situations during winter due to ice formations and drifting snow. Ledges and overhangs may produce ice formations which add to visual interest, and drifting snow along a wall or in pockets along a wall may help to reduce the apparent height. In areas of seasonal change, color variations in the landscape can be accompanied by color changes in a noise barrier through the use of plantings. Deciduous native plant materials that change color with the surrounding environment help to provide visual interest and relate a barrier to the landscape. Winter effect of plantings should be a consideration. Evergreens should be used where the primary function of the plantings is to provide year-round mass and texture. Perhaps the best solution is to specify groupings of both deciduous and evergreen plant materials. This provides both seasonal interest and year-round balance between a barrier and the environment.



Contrast of barrier increased by snow conditions

Effect of change in sun angle on barrier lighting conditions





Light and Shadow

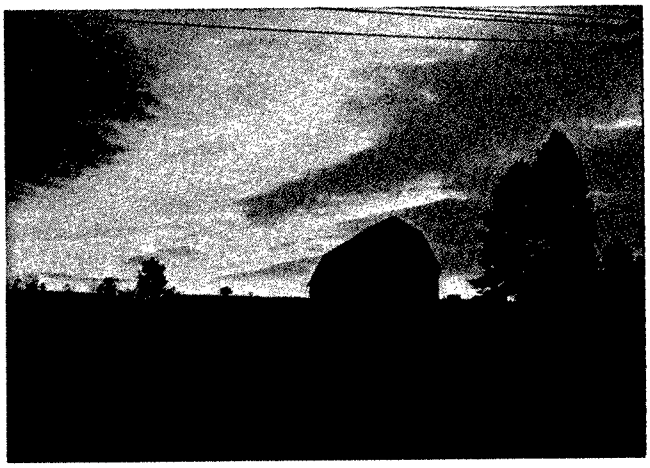
A barrier may appear different at various hours of the day due to the change in lighting conditions. The changing angle of the sun may produce back-lighted, side-lighted, and front-lighted conditions on a barrier during the course of a single day. Back-lighted barriers tend to be dominant mainly due to the increased awareness of form. This situation may be corrected through the use of a natural appearing tree line as a background for the distinctive form of the barrier. All but the coarsest of textures on a wall are subdued under this lighting condition. Therefore, barriers oriented to receive this type of light for the major portion of the day should employ the coarsest and boldest textures available if it is determined that texture is desirable. Colors, when placed in shadow, tend to appear darker; thus, lighter than normal colors should be utilized in walls where lightness is the objective. It is perhaps better to take advantage of a back-lighting condition, with its corresponding shadows and dark colors, as a means of reducing the visual awareness of a barrier. If a dark barrier is placed in front of a dark background of relatively taller trees, the barrier itself will tend to become invisible.

Side lighting produces maximum shadow effects on a noise barrier. Barriers which are likely to receive a majority of daylight from the side can achieve visual interest through rustication and other means of casting shadows to produce a three-dimensional effect. Trees placed to cast shadows on a barrier wall can impart a pleasant, ever-changing visual effect on an otherwise plain wall.

Barriers which are likely to be lighted from the front will appear to be brightest in color intensity; therefore, to avoid undesirable reflection of light, barrier colors should be somewhat darker.

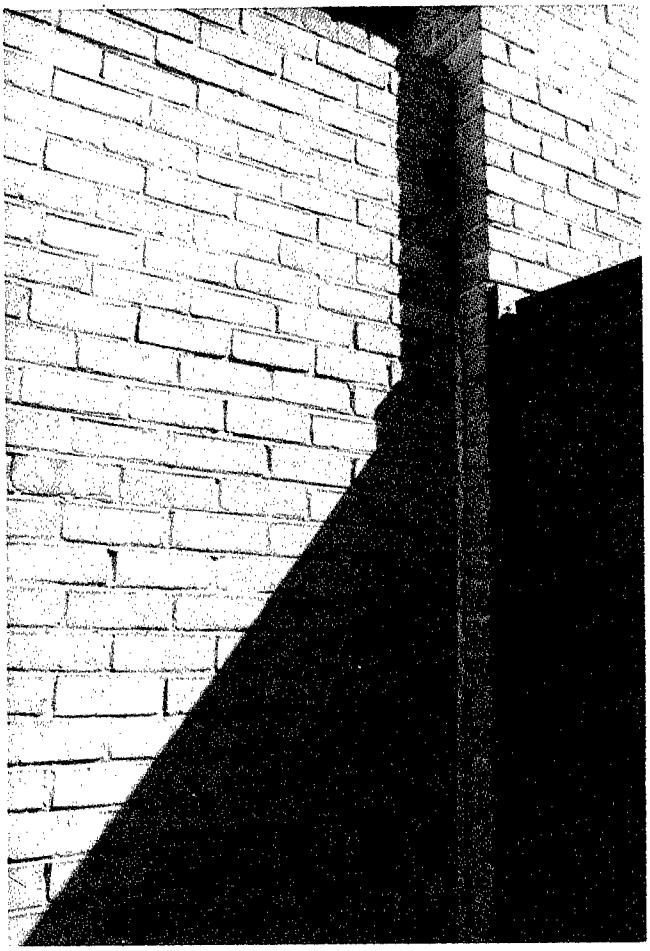
Barriers which are front lighted also will appear flat and two-dimensional. Visual interest can be heightened through the use of color variations at transition points to intensify the awareness of the change in line. Trees placed in front of a barrier help to increase the feeling of depth which is lacking in a barrier wall lighted from the front. They also cast shadows on the wall.

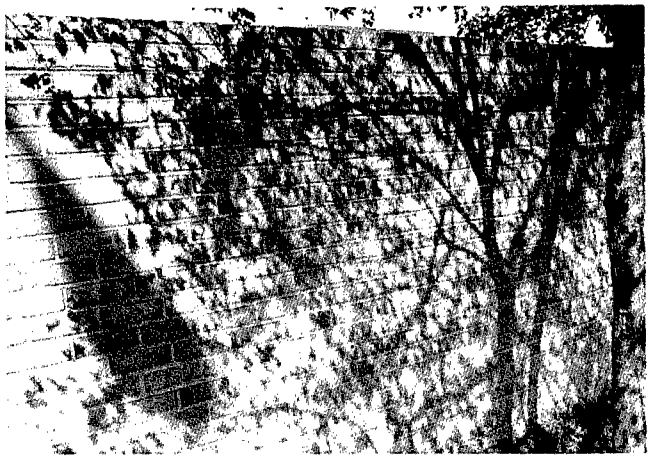
Shadow effects vary through the year due to the change in height of the sun. In winter, the sun is lowest on the horizon, with a corresponding increase in length of shadows. In summer, the sun is highest in the sky, with shortest shadows as a result. This changing nature of lighting conditions should be considered by the designer when designing for shadow effect on noise barriers. The proposed effect may in fact be effective for only a small portion of the year.



Back lighted objects are distinguishable by their form. Texture is difficult to perceive.

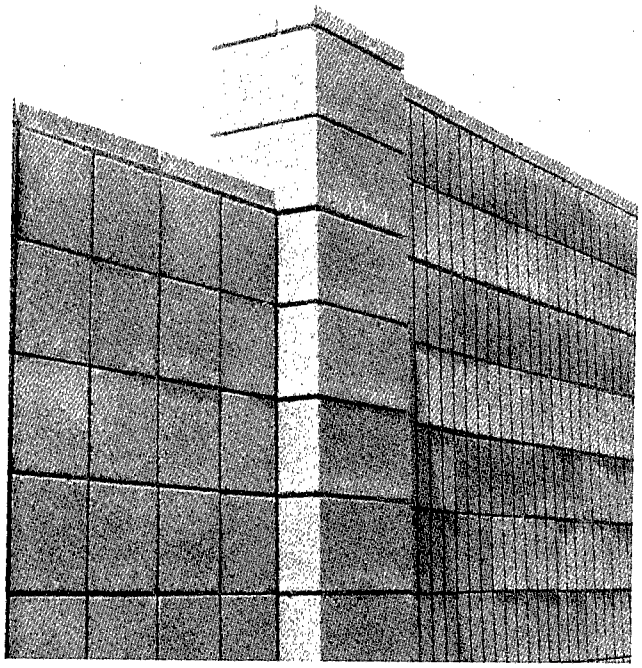
The line of this wall follows the natural tree line. When backlighted, the trees become the dominant form, rather than the wall.

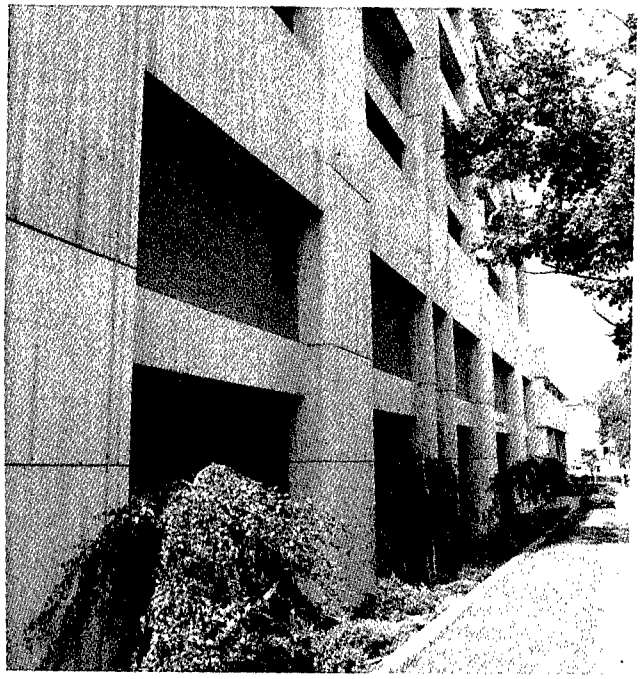




Shadow effects

A change in color or texture at transition points intensifies the awareness of the change.



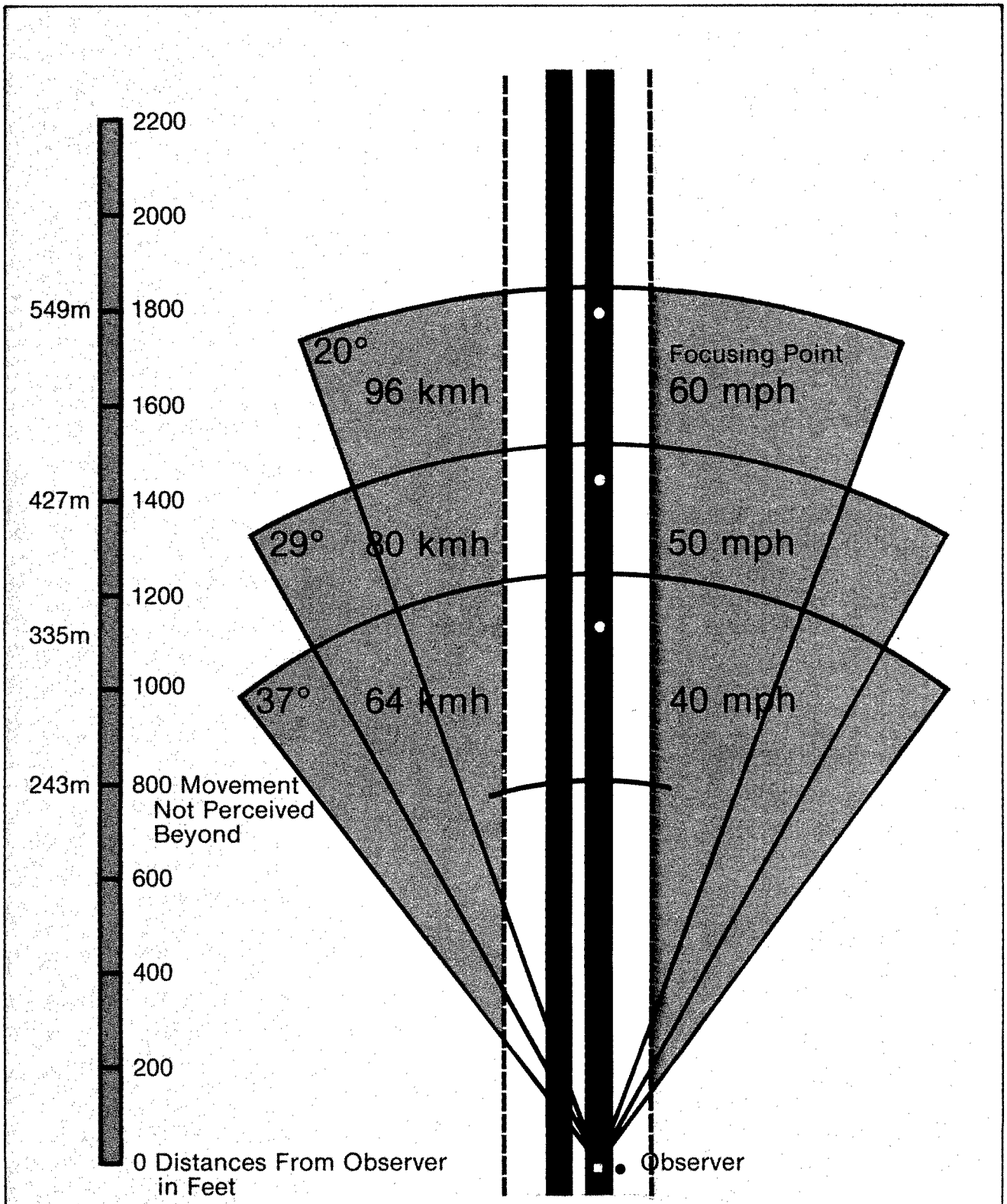


Change in color

Motion

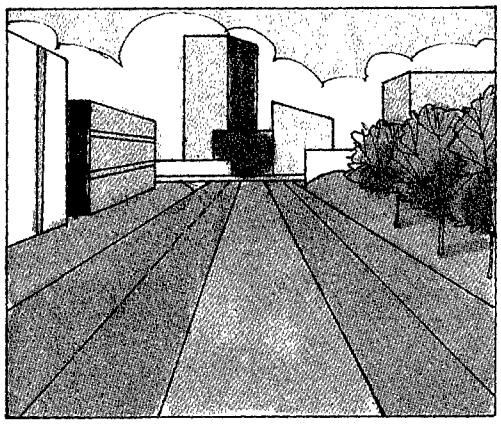
The motorist is a moving observer, yet from an automobile, the apparent motion is not in the vehicle, but in the objects that line the roadway. At 60 miles per hour (96 km/hr), the observer is moving at 88 feet per second (27 m/sec). It has been determined that objects placed the same distance from the road as the viewing speed in miles per hour will appear blurred to the driver. At 60 miles per hour (96 km/hr), then, all objects placed within 60 feet (18 m) of the driving lane will appear blurred. Objects in the foreground move most rapidly, and may even tend to disappear. Objects that are of medium distance from the road, approaching the equivalent speed in distance, are just beginning to blur. Distant objects are the only distinctly visible components of the view which the motorist can observe in detail and at leisure. Fine detail in a noise barrier which is to be viewed by the motorist is unnecessary. A barrier will occupy space in the foreground or middle ground of the overall highway scene; in this position, barrier details become a blur to the motorist.

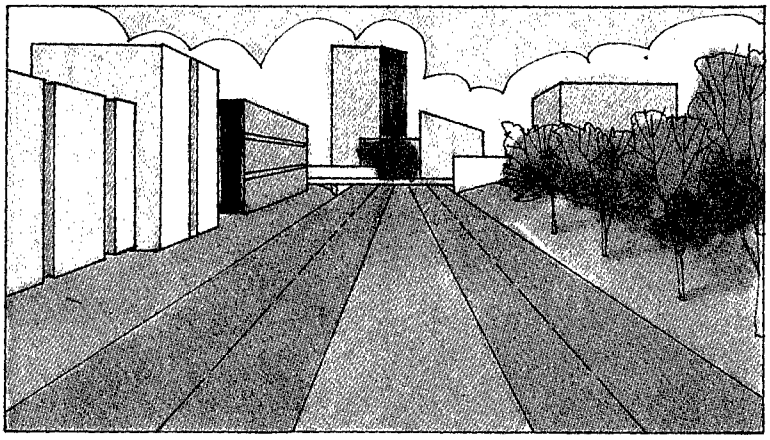
The peripheral vision of a motorist is related to speed. As speed increases, the eye unconsciously tends to narrow its field of vision in order to concentrate on the road ahead. Objects which are outside of this limit of peripheral vision are vague, particularly if they are low in contrast with their surroundings. Objects that are of high contrast at this limit of vision tend to attract the eye and distract the attention from the roadway. Noise barriers, as objects along the roadway, should not distract the attention of the motorist. Barriers with high contrast, particularly those which repeat a series of contrasting colors, should be avoided. Flickers of light, caused by contrasting colors, repetitive tree plantings or other means, can result in driver annoyance and distraction.

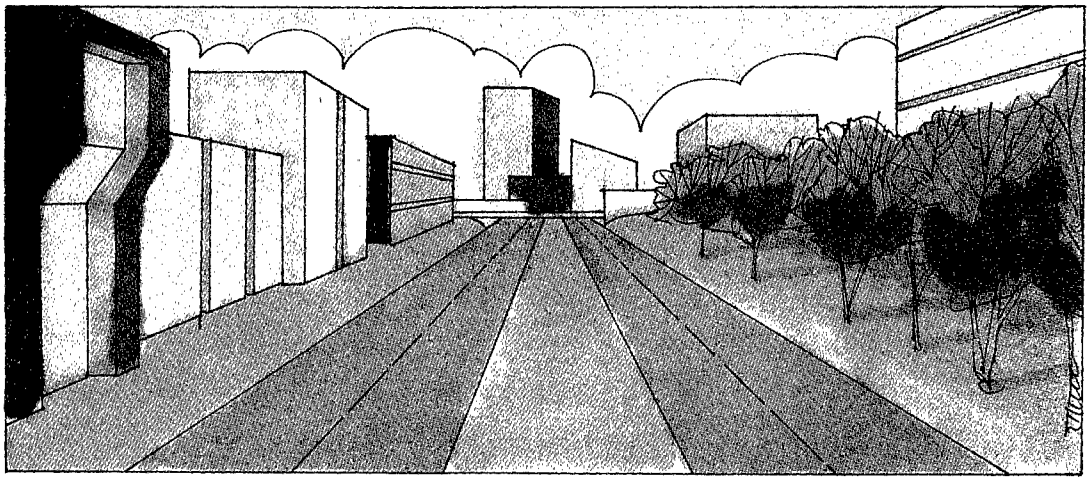


Relationship between focusing distance, angle of vision, and distance of foreground detail at speed of 40 mph, 50 mph, and 60 mph.

Relationships of speed to peripheral vision







The pedestrian is a slowly moving or stationary observer. While walking, one averages a speed of 2½ miles per hour. At this speed, peripheral vision approaches 180 degrees, and the observer has the opportunity to turn his head and concentrate on any object which is of interest without seriously affecting forward movement. In fact, one is often free to stop and examine objects closely. The pedestrian, then, is more likely to see and appreciate detail in a noise barrier and to enjoy the experience of moving slowly past a barrier which incorporates a change in visual interest.

The resident who lives adjacent to a noise barrier views the barrier as a static element in the visual scene. There is little or no motion involved in viewing the barrier, and no opportunity for sequential change in the perception of the barrier in its entirety. As a static element, the noise barrier should provide visual interest in the form of detailed textures, complemented by the interesting arrangement and combination of plantings which are of interest in themselves.

A noise barrier can and should provide visual interest for the observer, regardless of the speed of the observer or the position from which it is viewed. This can be accomplished by consideration for the separate, and distinctly different, viewing situations which accompany the placement of a noise barrier in the environment. The designer must consider the visual needs of the motorist, the pedestrian, and the resident as unique and separate elements that require separate design treatment.

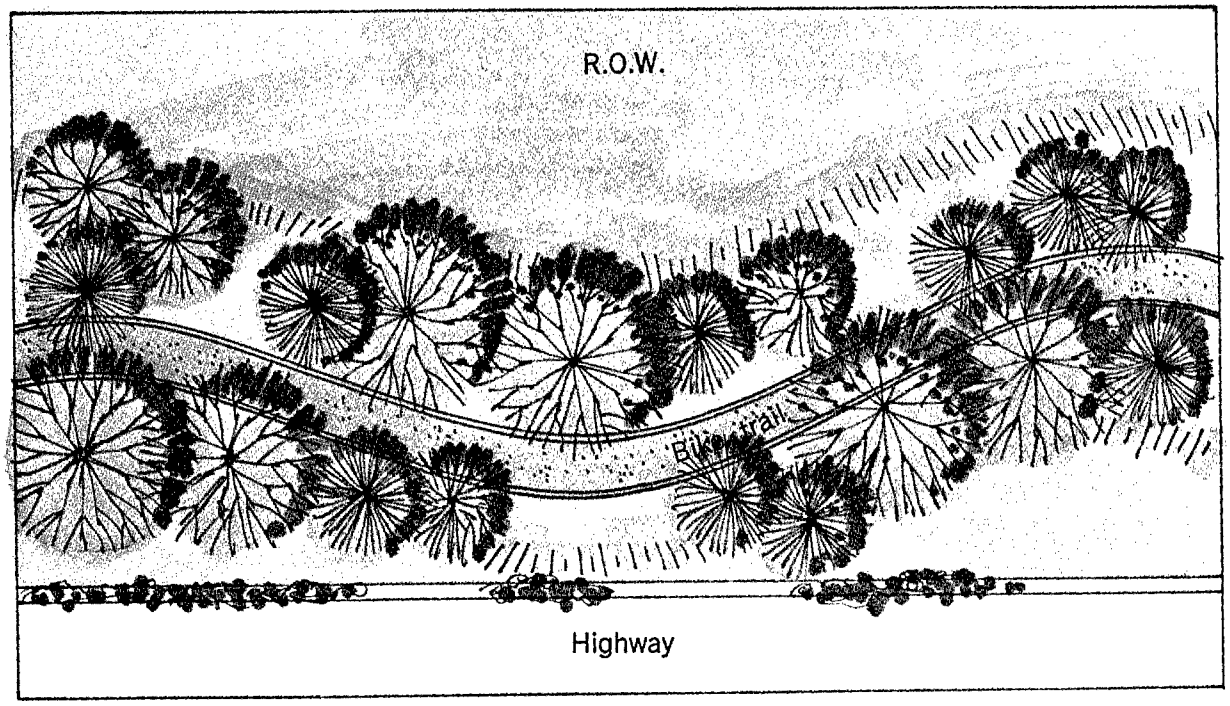
Chapter 5

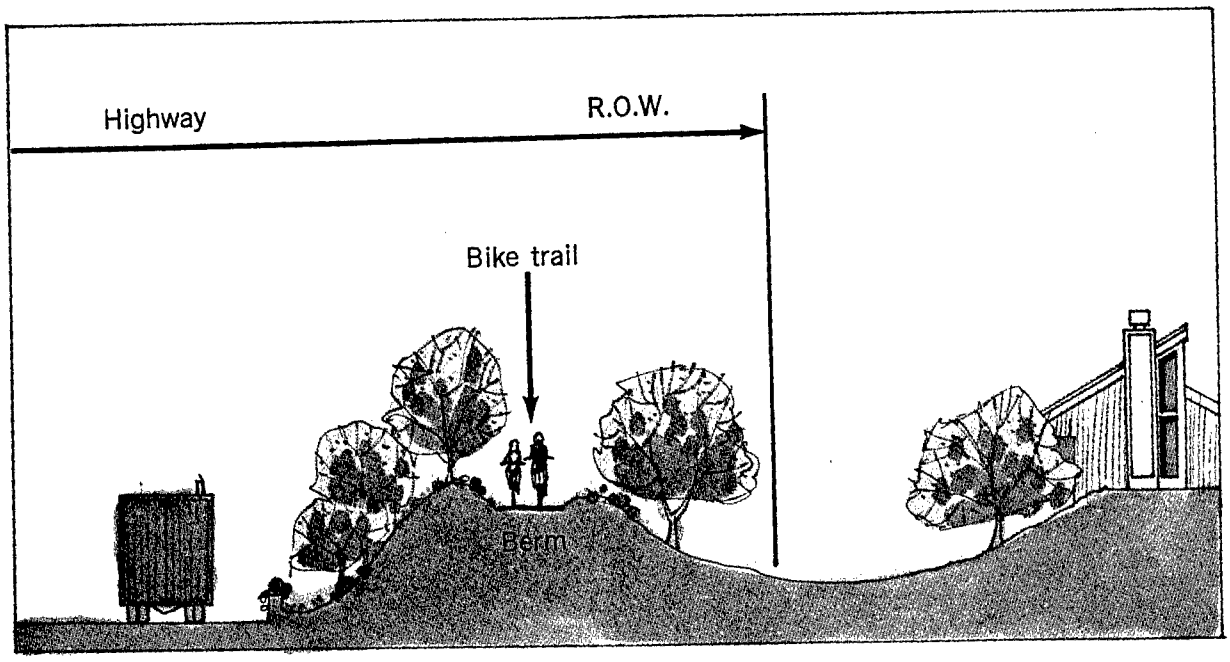
Design Concepts

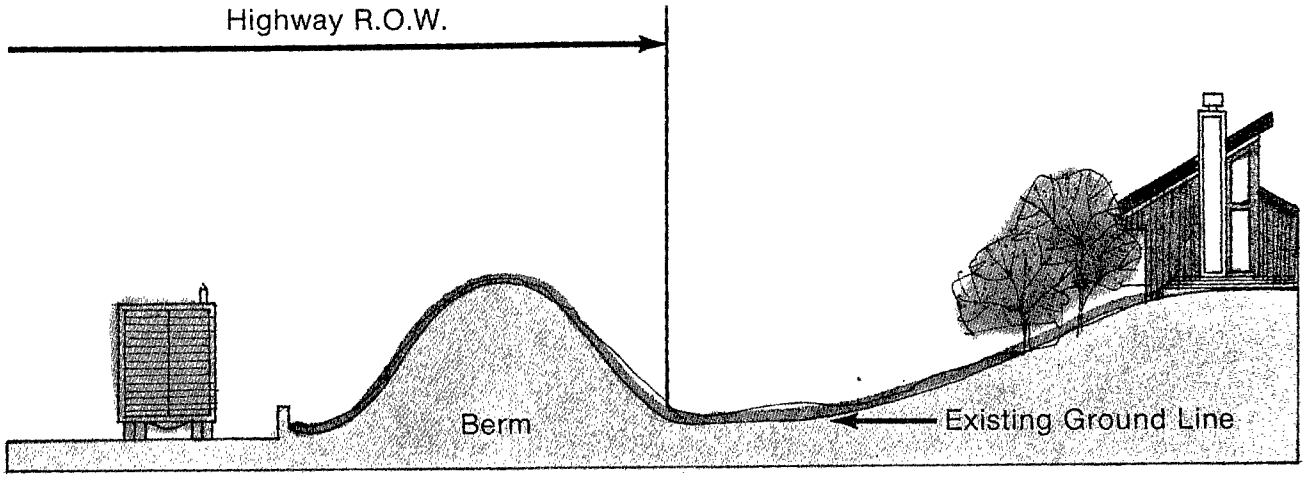
Use of Right-of-Way

Open space in urban situations is often at a premium, and available land must be put to intelligent use. Highways serve as linkages between communities, allowing for the efficient transport of people and goods by motor vehicle. The bicycle is an efficient form of transportation for short distances within a community, but adequate, safe linkages within communities or between neighboring communities are often lacking. Bicycles will be used by the public for daily transportation when adequate facilities are available. The highway right-of-way is a potential linkage which is often closed to public access, and is of little use to both the highway agency and the general public. Separation between vehicular and pedestrian traffic is required for safety. In most cases, a noise barrier can also serve as an effective safety barrier. The remaining right-of-way on the community side should be re-evaluated as part of the noise abatement project, and considered for public use. Bicycle paths and linear parks are feasible uses for this land, and can supply needed transportation linkages and recreational facilities for the public.

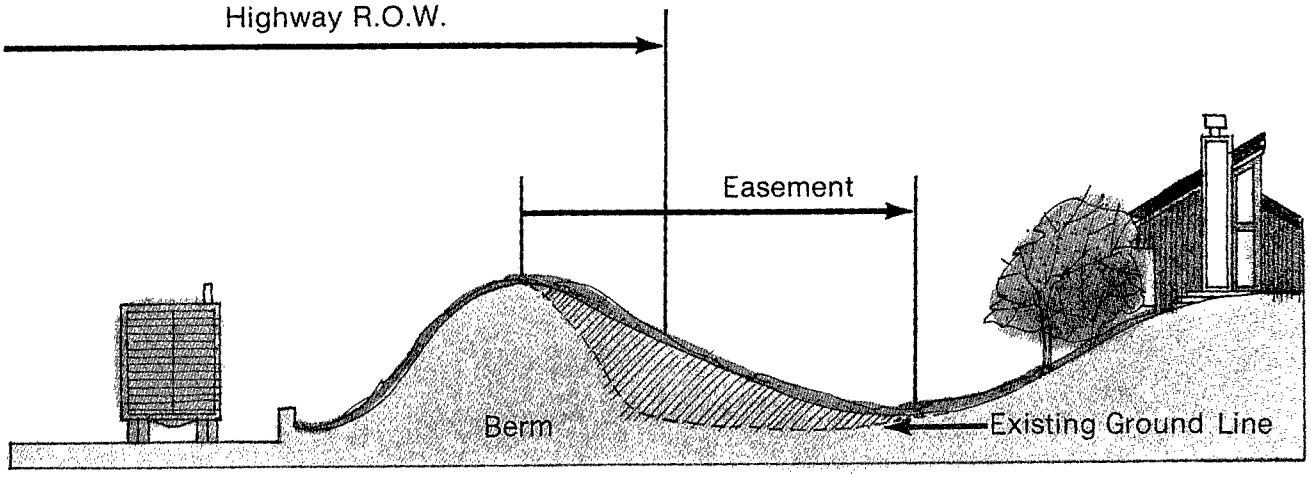
Earth berms can easily incorporate a bicycle trail as part of the design. Paths can vary in both horizontal and vertical alignment, to provide an interesting and pleasant experience for the bicyclist. Bicycle paths should be confined to the community side of the berm where possible, to provide both visual and physical separation from the highway. Similar paths can be provided for pedestrian use. Often private land which adjoins the highway right-of-way is not developed because of limited access. It may be possible to obtain an easement for community recreational use of this land. The easement would greatly expand the possibilities for recreation in a linear park.


R.O.W.
Bike trail
Highway


Highway
R.O.W.
Bike trail
Berm



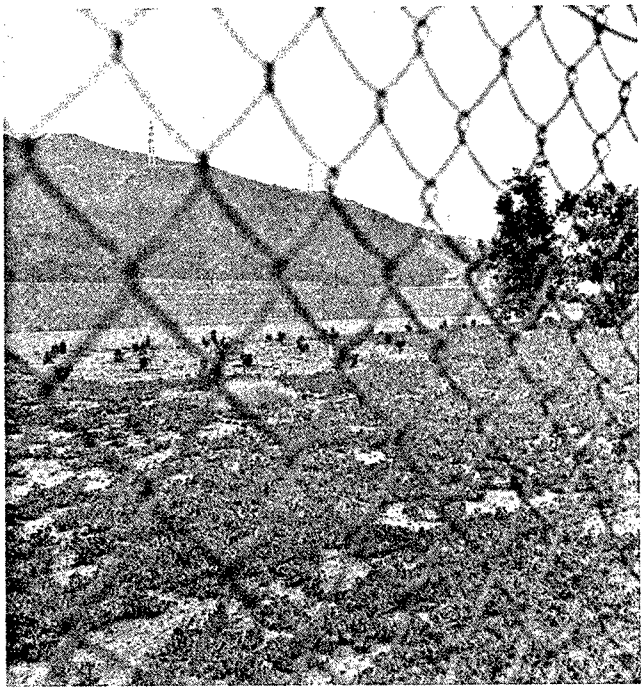
Without Easement



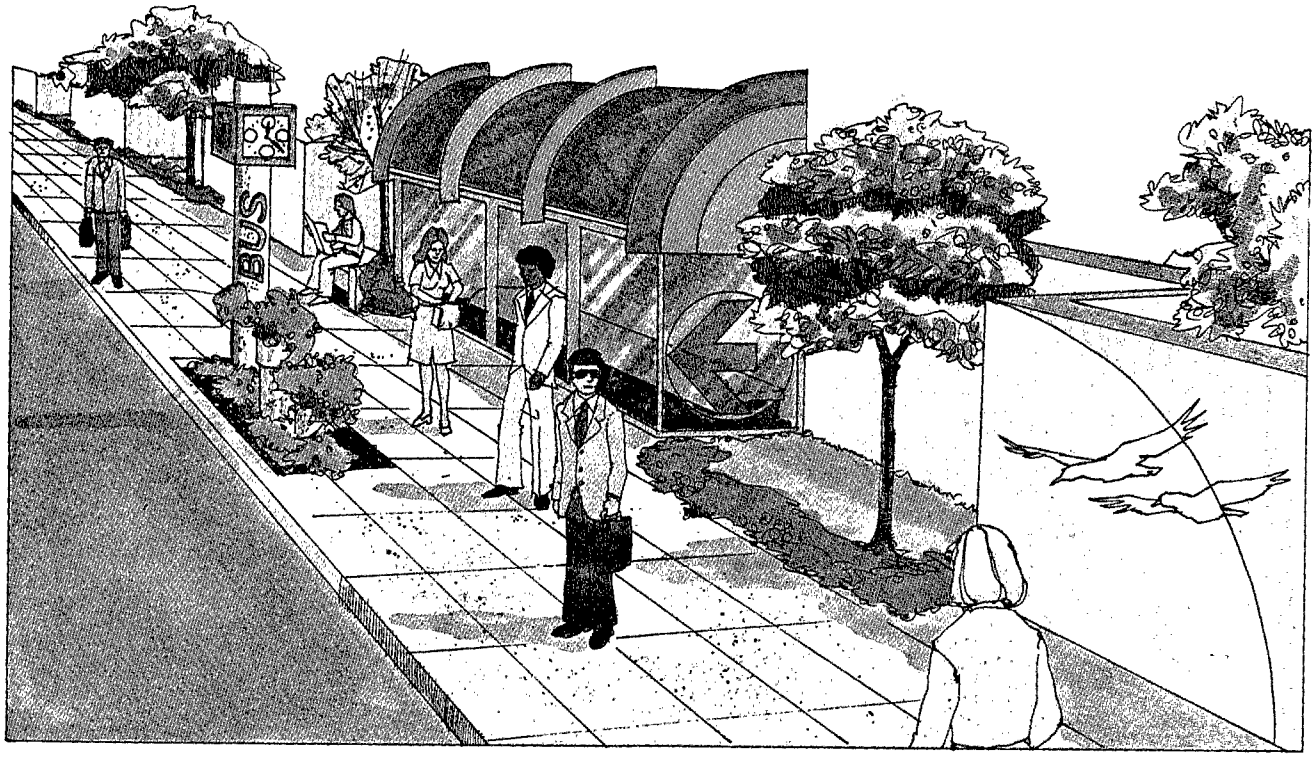
Use of Easement to Blend Berm into Natural Land Contours

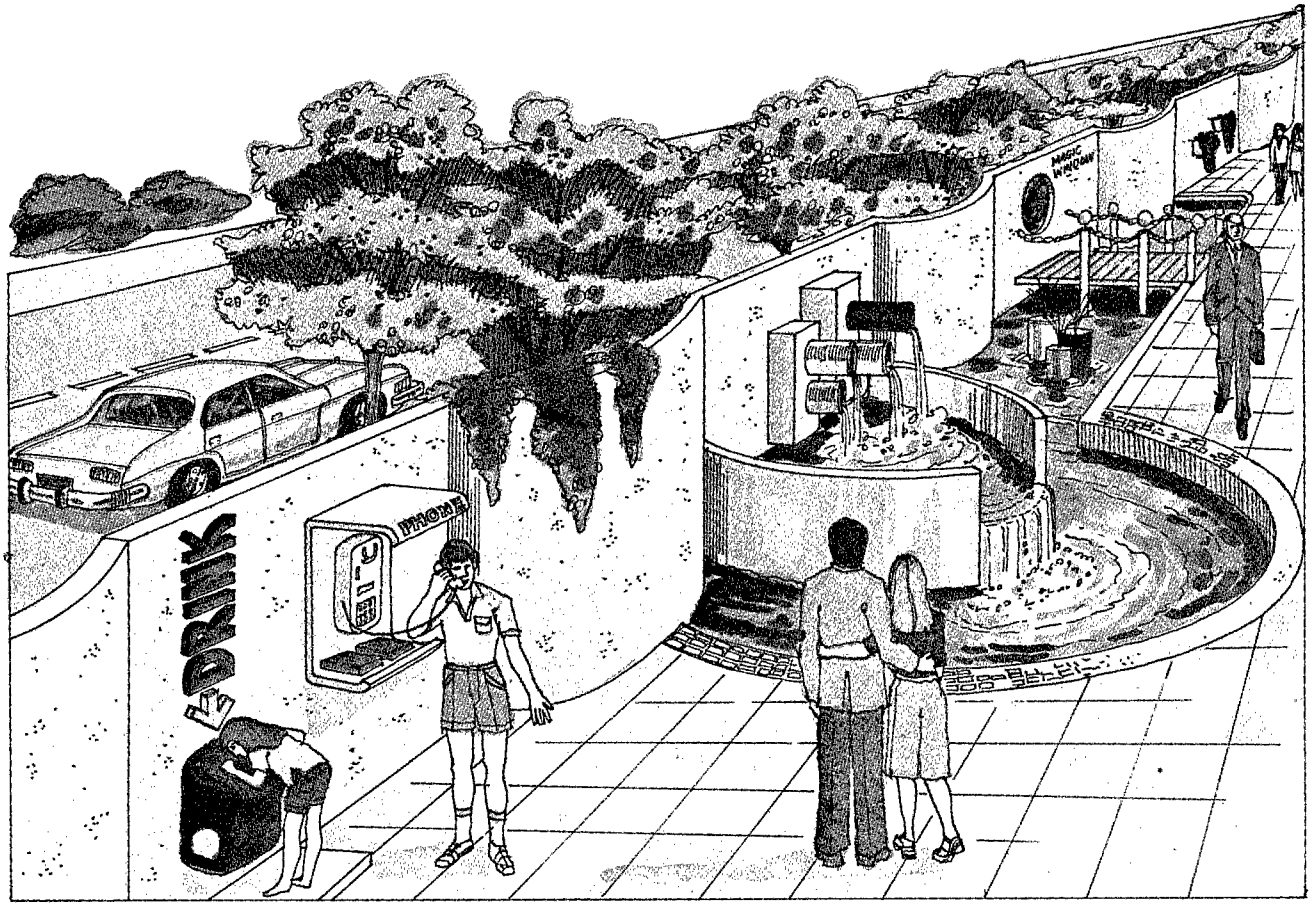
An easement may also be a means of reducing the slope ratio on earth berms. Adjacent landowners may allow filling on their land to avoid the abrupt transition in height between ground plane and earth berm. This allows for more efficient use of the slope and may allow for increased planting or better visual integration between the berm and the landscape. There are advantages to the private landowner, in terms of visual quality and lowered taxes on easement property, which may make this possibility worthy of consideration.

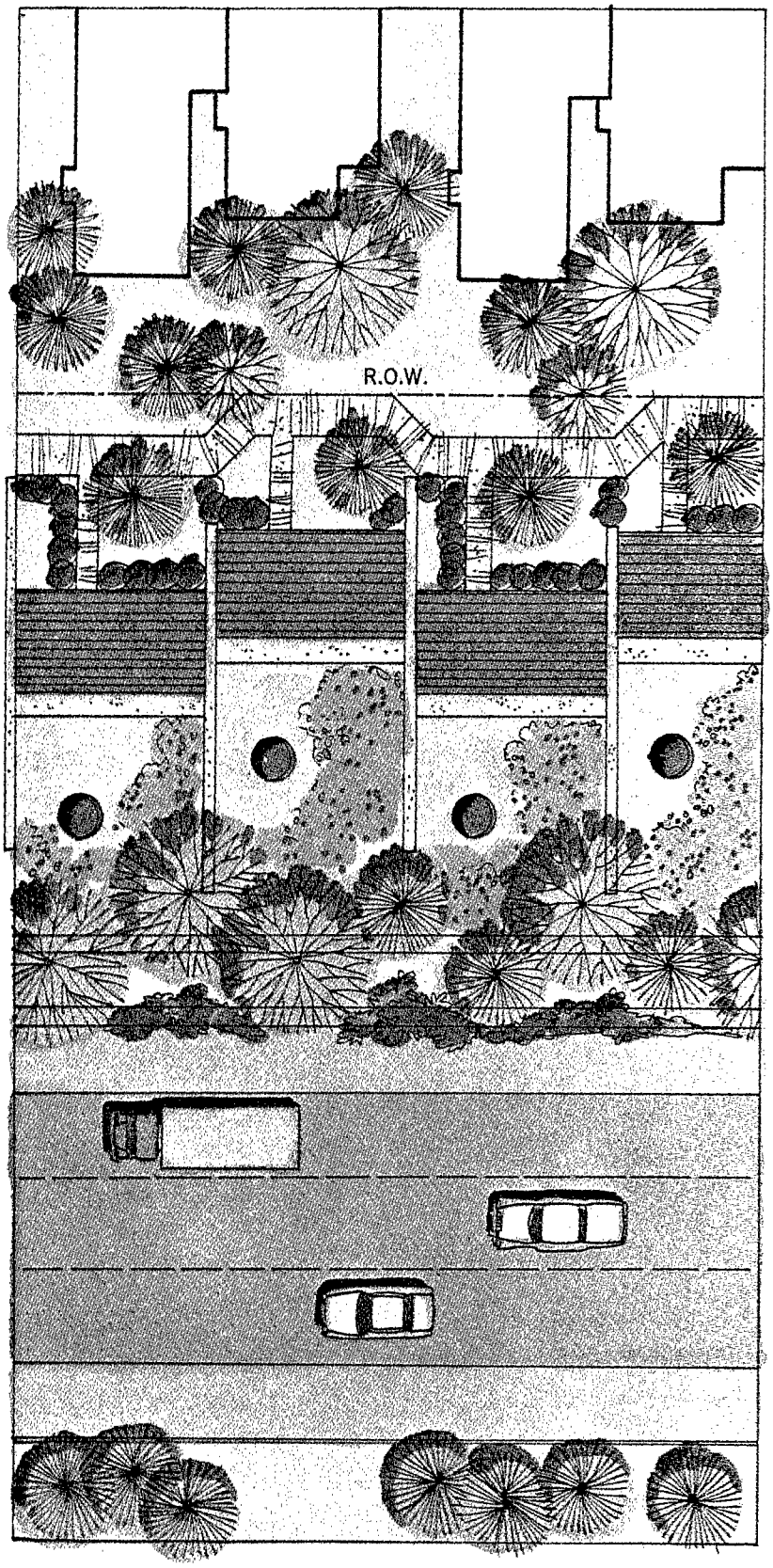
Noise barrier walls can also become good neighbors, particularly when excess right-of-way is converted to community recreational use. Small parcels of property can become miniature parks and playgrounds, sitting areas, bus shelters, or outdoor meeting areas. Walls make good backstops for games, such as tennis, handball, basketball, etc. A wall can be functional, rather than static. Noise walls can become functional components of structures which house commercial activities or other less noise sensitive uses. The multiple use of noise barriers is a possibility which exists but has received little attention in the past.



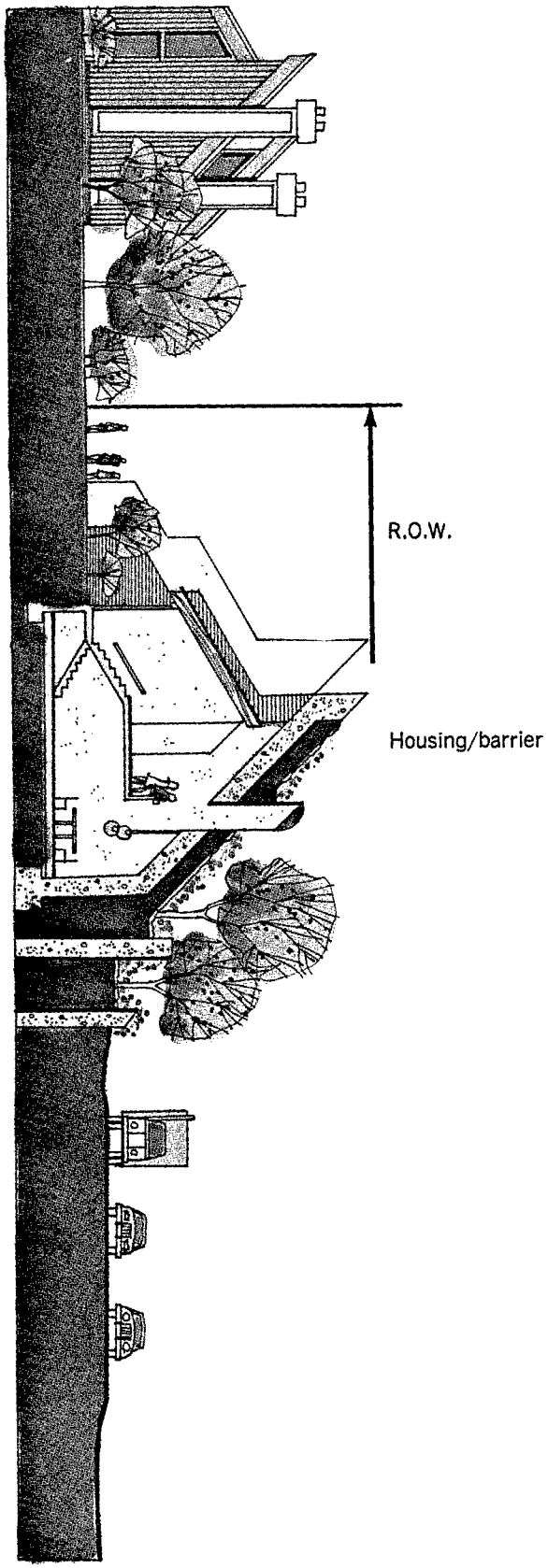
Excess right-of-way which could provide recreational space for the community. Development of spaces such as this can help to gain public acceptance of the barrier.


BUS


DRINK
PHONE


R.O.W.
Housing/barrier

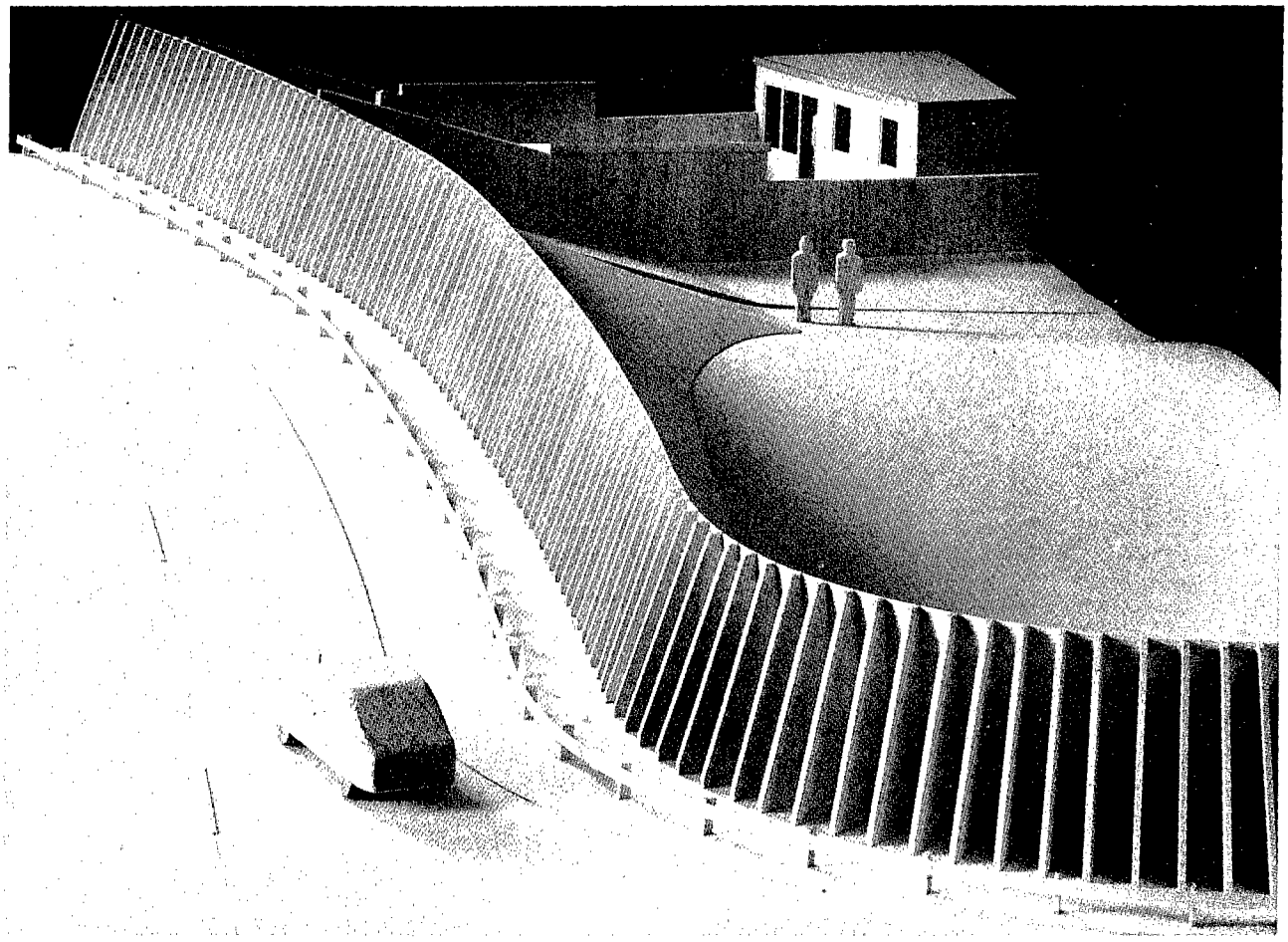
Multiple use of noise barrier as a structure



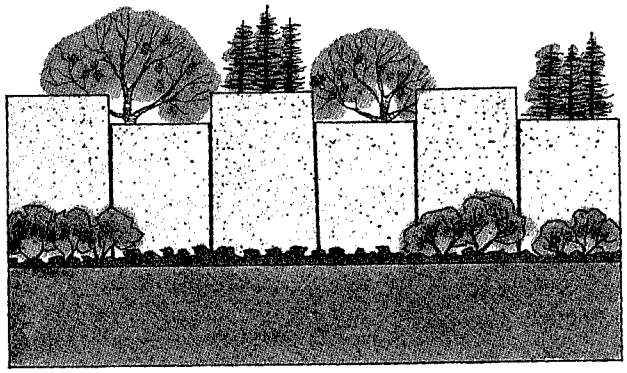
Concepts in Wall Design

Through the application of basic design principles contained in this manual, there are many possibilities for the aesthetic design of noise barrier walls. This section illustrates a number of design concepts which show how these principles were applied. The wall designs contained in this section should not be construed as recommended treatments, suitable for wide application, since *the unique requirements of each site should determine the type and design of the barrier chosen for that site*. These are presented as an illustration of the application of individual principles, which may or may not be suitable for a given site.

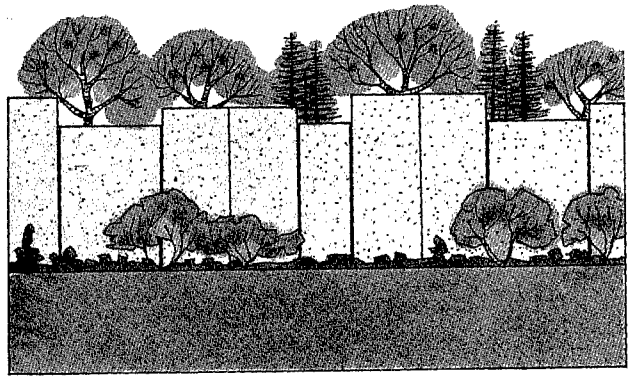
These designs illustrate the use of vertical lines to minimize the predominantly horizontal line of a noise barrier.



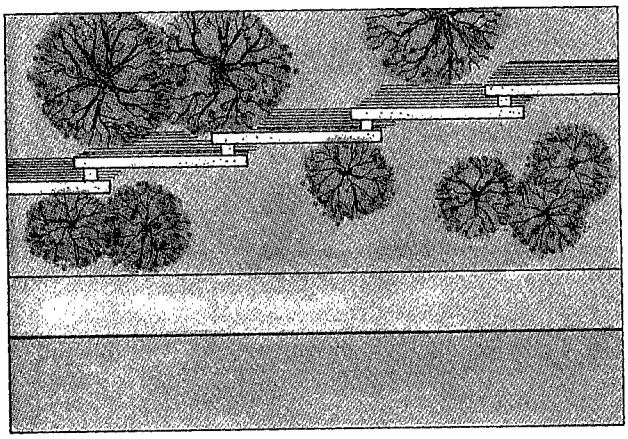
Noise barrier design proposed by Swedish architect Peter Gavel



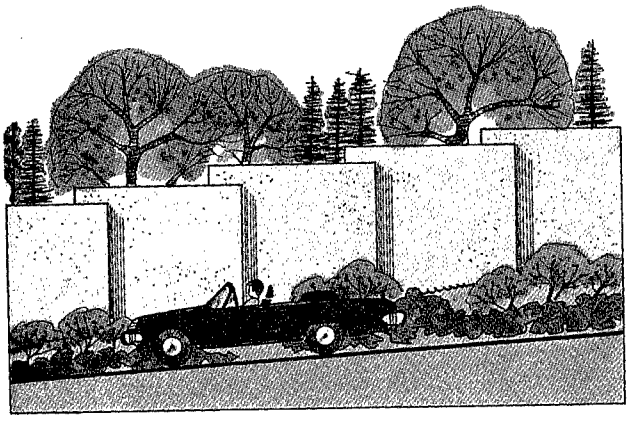
Repetitive: too many panels of same sizes



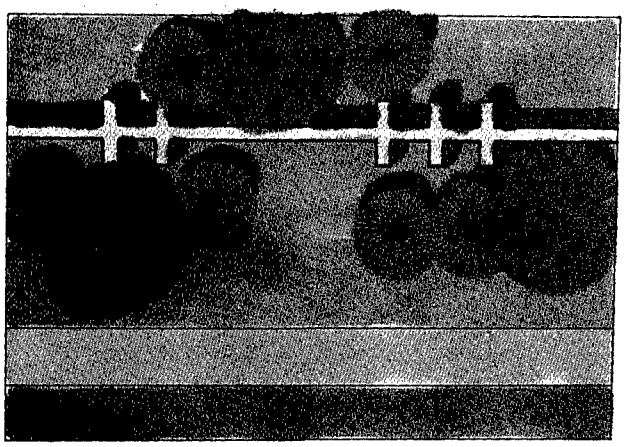
Better: alternating panels of various sizes



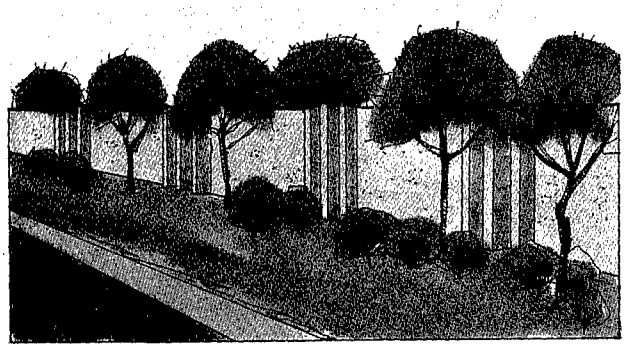
Plan



Elevation

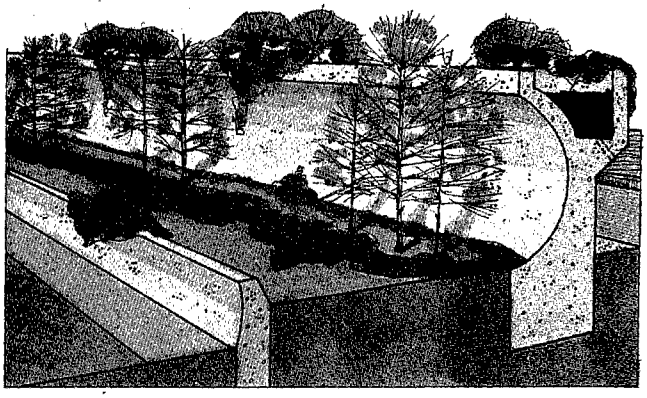


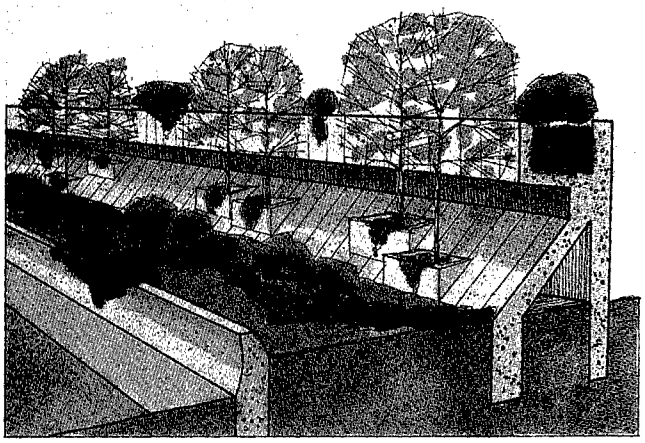
Plan



Perspective

A curved or angled wall, combined with raised planting pockets, serves to reduce the strongly linear appearance of a barrier. Vertical lines help to break up the blank face of the wall. A combination of horizontal and vertical lines in a wall helps to reduce the apparent height of the wall.

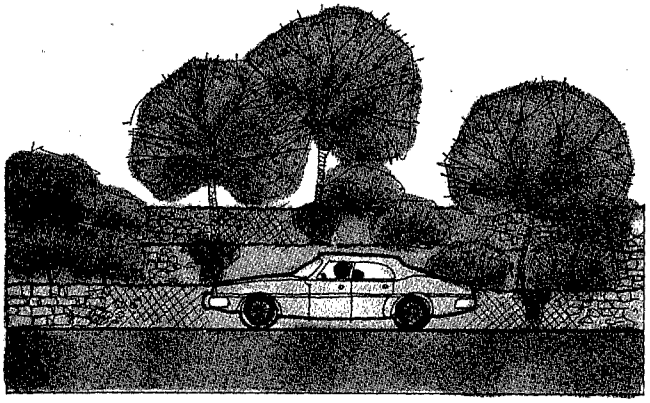




Angled wall with planter

A wall which steps back appears lower in height than it actually is. This serves to open up the view for the motorist rather than encroaching upon it. A wall such as this provides space for planting which helps to break up the predominantly linear appearance of a straight wall.

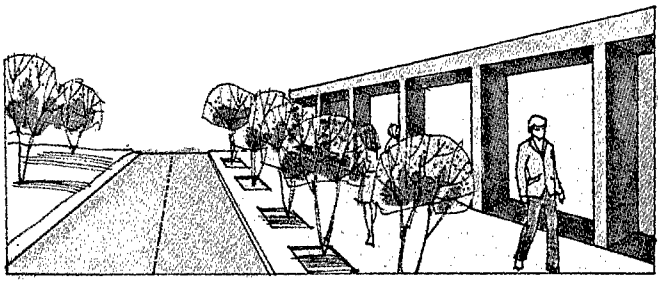
Section

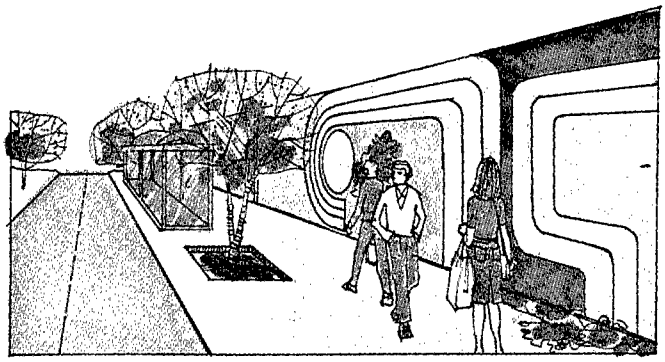


Elevation

Use of planting pocket in gabion wall

Wall graphics can introduce color into pedestrian spaces. In addition, graphics can serve to provide directional information to both motorists and pedestrians. Graphics help to add visual interest to a plain wall, and, in addition, may be used to balance a strongly horizontal line by the introduction of vertical lines. Through the technique of shading, wall graphics can create the illusion of depth on what is actually a straight, unbroken wall. Wall graphics can improve the visual quality of existing walls at a relatively low cost. Citizen involvement in the selection of a graphic theme, particularly school age children and teenagers, can help to reduce the possibility of vandalism to a completed design.



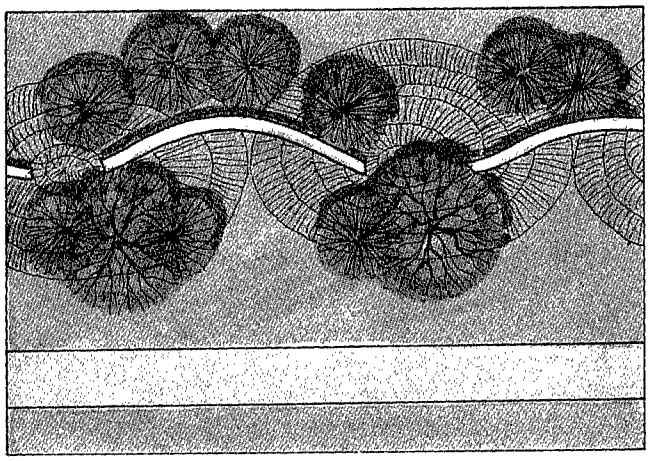


Concepts in Combination Barriers

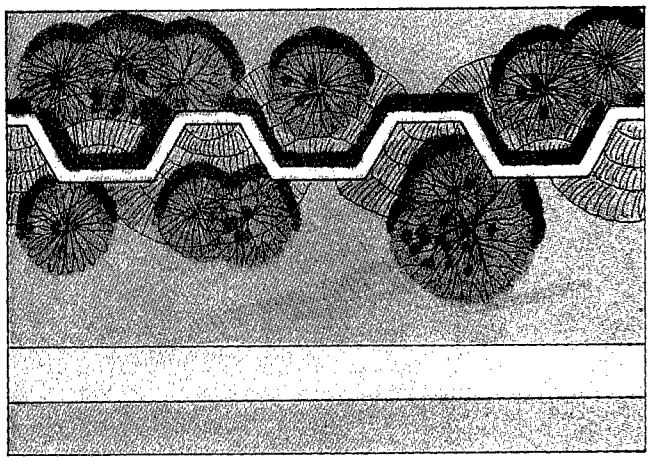
Combination barriers use both earth berms and walls to achieve the desired height. Earth berms may also be used in combination with walls to reduce the apparent height or to add visual interest through variety in the noise barrier. Where space limits the use of a berm alone, a berm may be constructed on only one side of a wall to help reduce the undesirable dominance of the wall. This is especially beneficial on the residential side of a barrier. Berms alternated on both sides of a wall where right of way is limited provide for planting areas on both sides of a barrier. This helps to reduce the apparent height of the wall and introduces variety into what might otherwise be a straight, overly dominant wall.

Berms may also alternate with walls to provide variety and to reduce visual impact. The berms break up the monotony of a long, straight wall and help to relate the wall to the ground plane.

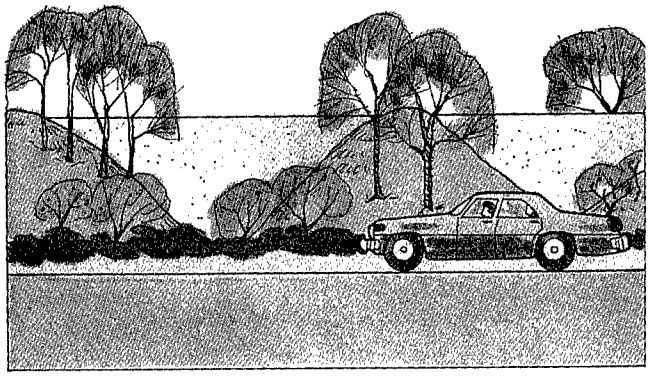
Combination berm and wall



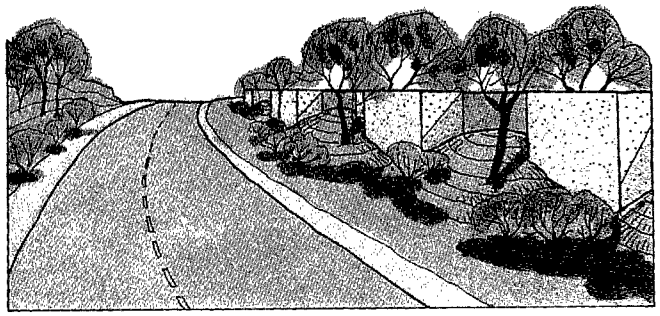
Plan



Plan

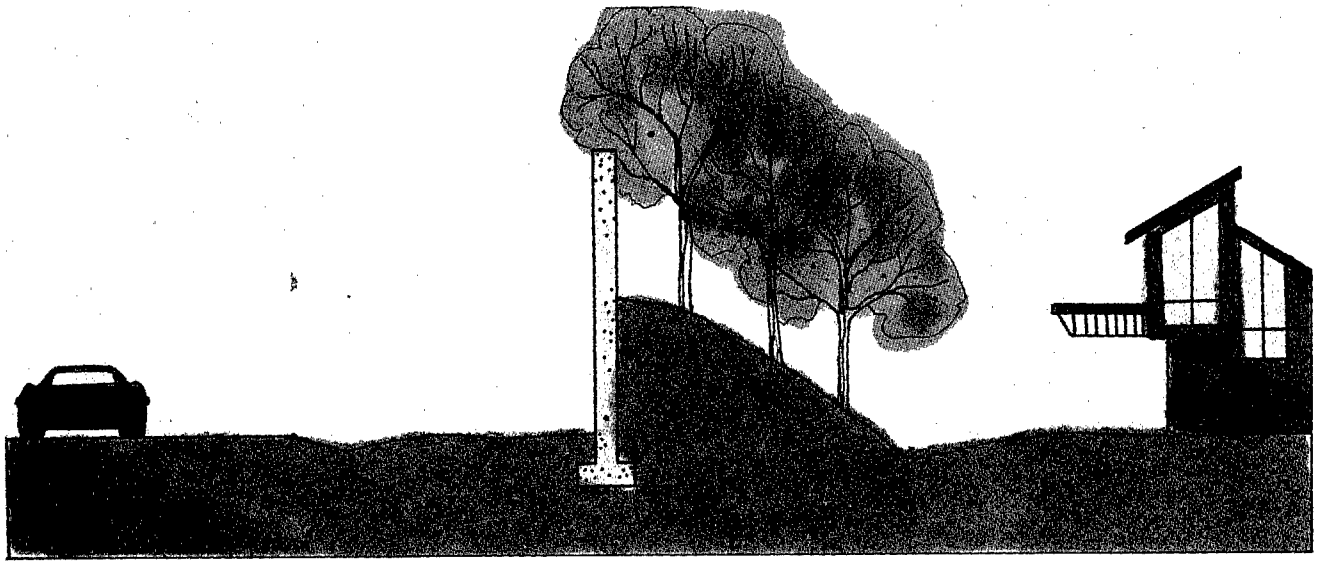


Elevation



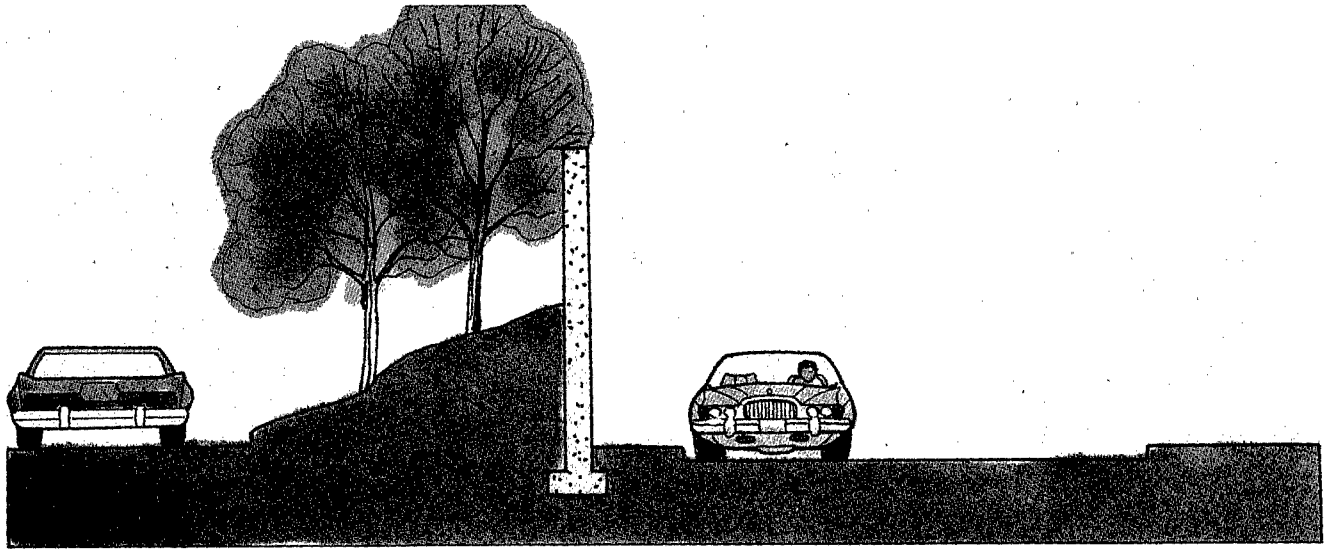
Perspective

Berm/wall combination for narrow right of way



Highway Residential

Earth berm on residential side of barrier.



Highway Service Road

Earth berm on highway side of barrier.

A wall placed on top of a berm may vary in an irregular manner to provide for a variation in line, a break in color or texture, or level space for planting of trees and shrubs.

Median

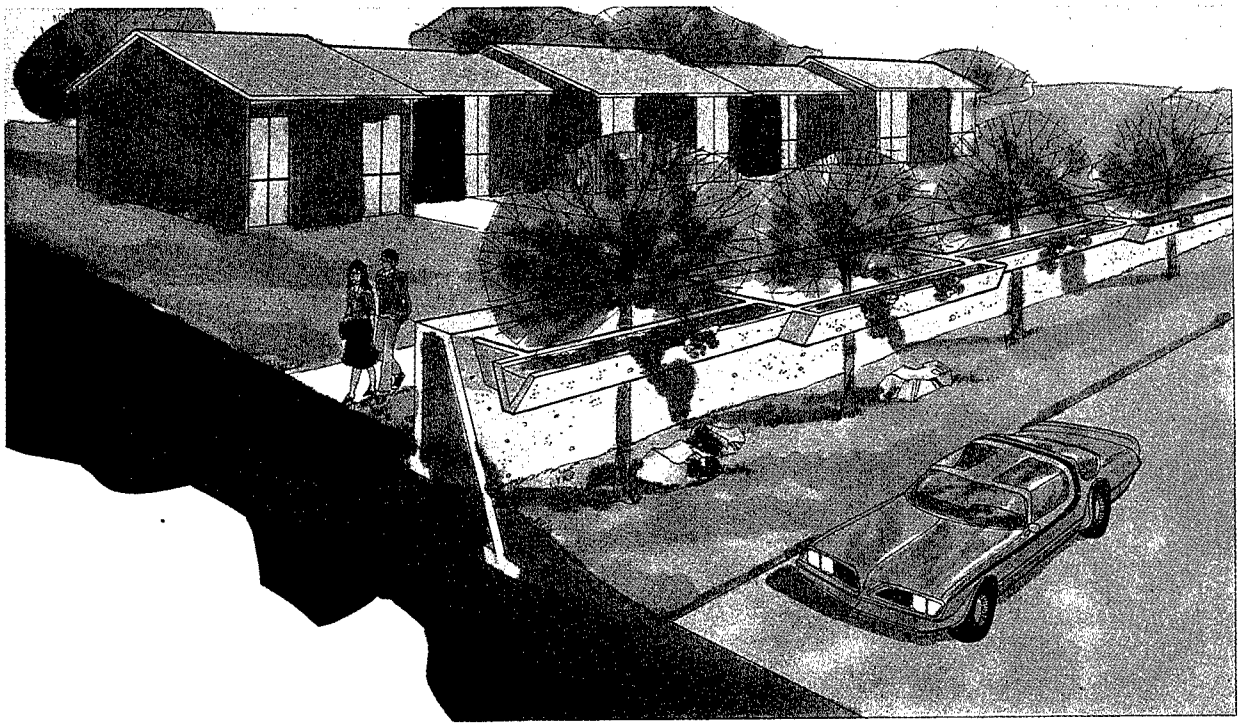
Pavement

Earth Berm with Wall

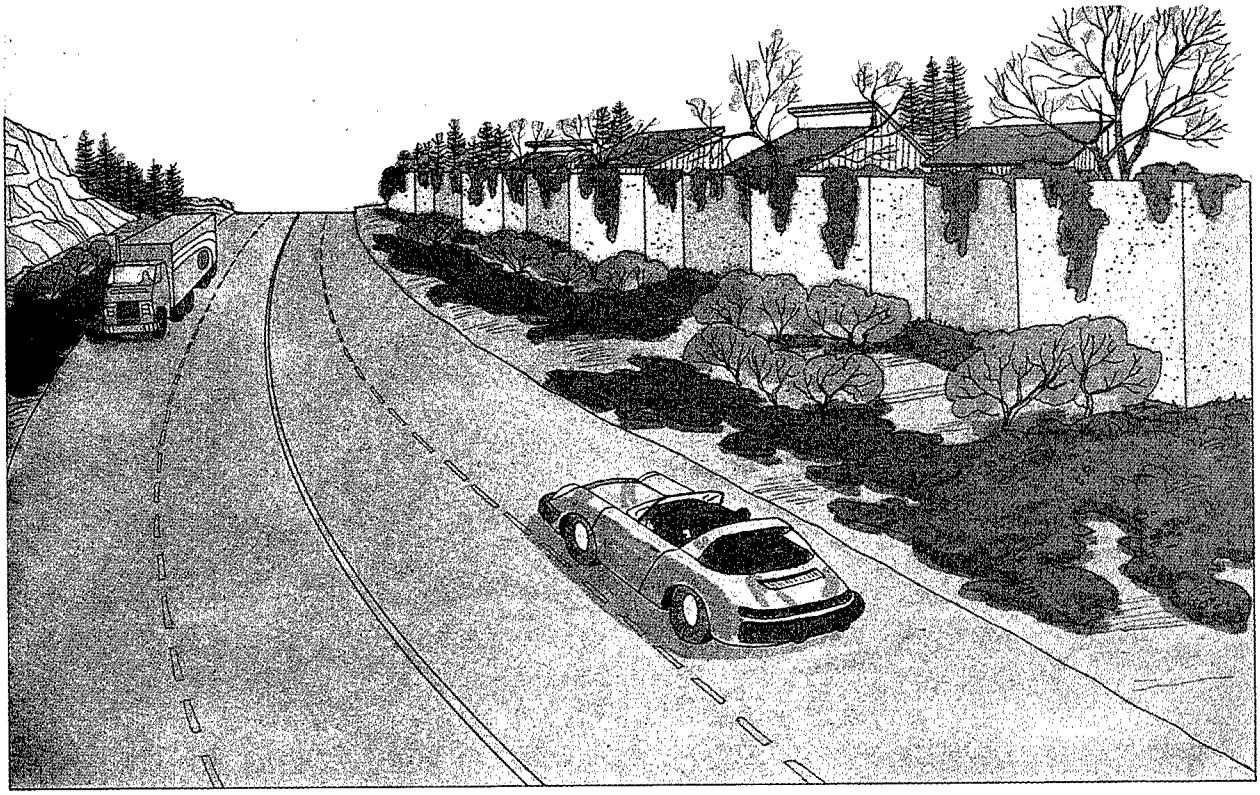
R.O.W. Line

Community

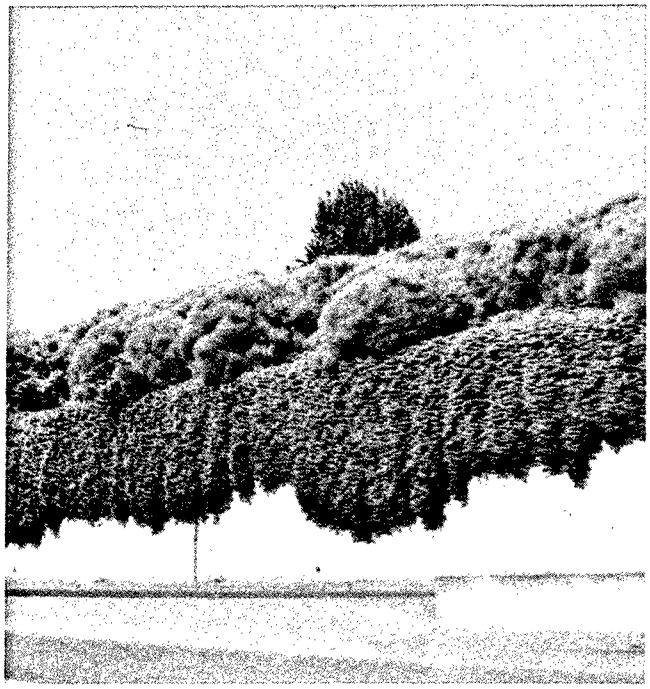
Plan 1" = 20'-0"



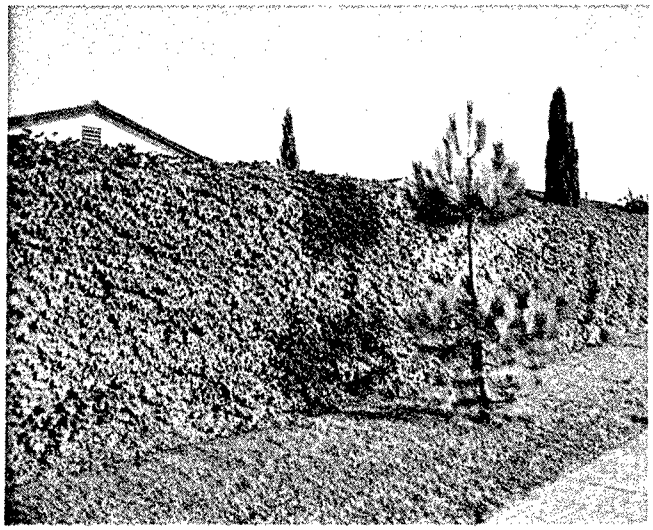
Perspective of combination retaining wall/noise barrier



Perspective of castellated wall



Vines can be used to add visual interest or to cover a plain wall.



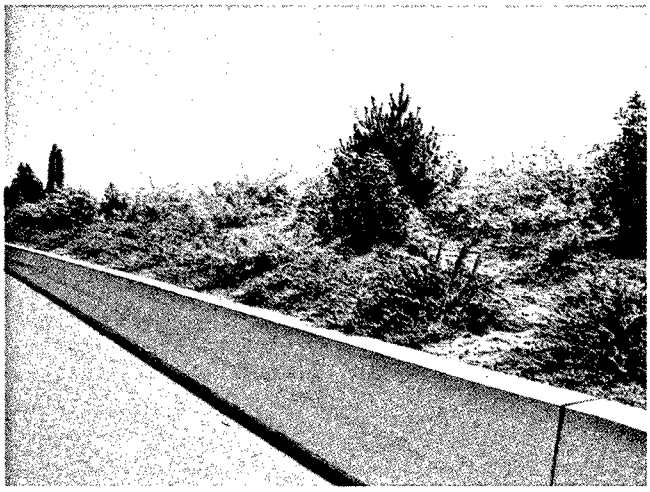
The Functional Role of Plantings

Plantings are perhaps the most effective, economical means available to reduce the adverse visual impact of a noise wall. When used in combination with a structure, plantings serve to link the structure with the landscape. Trees and shrubs may provide all of the design elements in a composition: line, form, color, and texture.

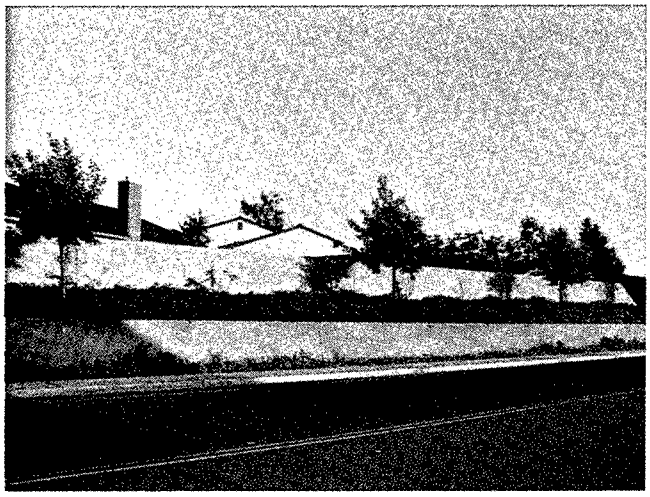
A massing of trees and shrubs can create a natural transition area at the end of a wall. On, or in front of a wall, they provide color and texture or serve to break the straight line of a wall in either plan or elevation. Vines may be used to create textural patterns on a wall or to hide a plain, uninteresting wall. Trees can provide needed vertical height for predominantly horizontal walls or earth berms. Plants offer variety—in size, shape, or color.

Plants can be used to increase or decrease contrast, create a sequence through their arrangements, balance an axis, and overcome dominance. Plants help to reduce the massive scale of high walls and balance their proportions. Plants can provide visual interest to the moving or stationary observer, regardless of distance or position. Interest depends on the size, textures and heights of plants chosen. As the seasons change, plants provide a changing display of color. In the bright summer sunshine, plants can provide shade or block reflections from light colored surfaces. In winter, interesting shadow effects can be cast on walls by bare branches. Then, the many variations in color and texture of bark and twigs also become a source of visual interest. Tree leaves and branches introduce motion into an otherwise static environment by moving with the wind. But the most important function provided by plants is that people relate to them because they are living, growing, changing elements in a sterile, manmade environment.

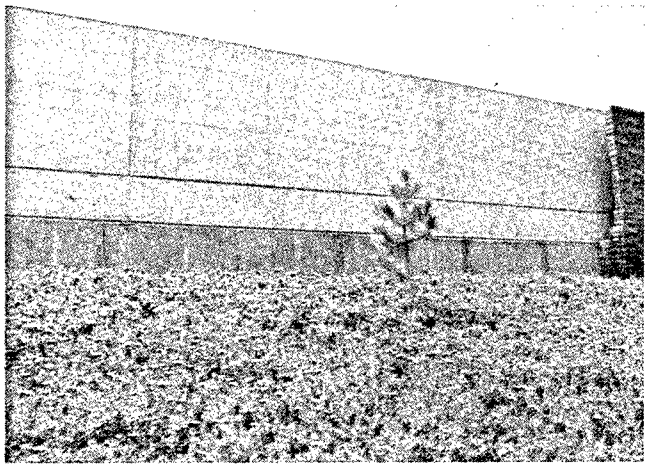
Vines can be used as an accent on a wall.



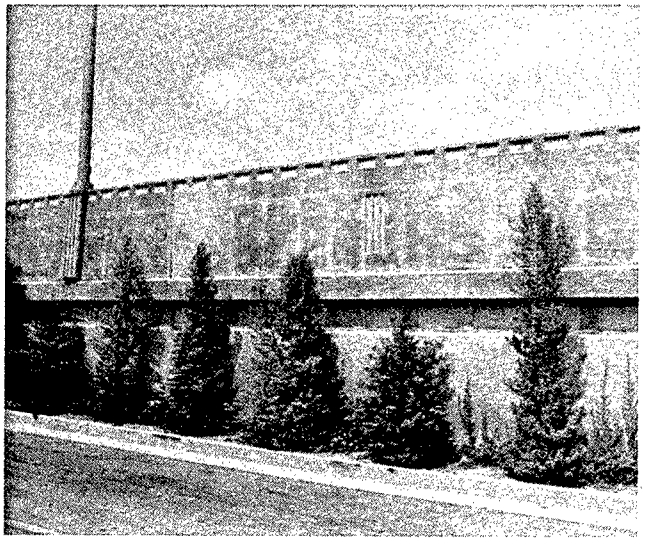
Good combination of plant masses and variation in heights



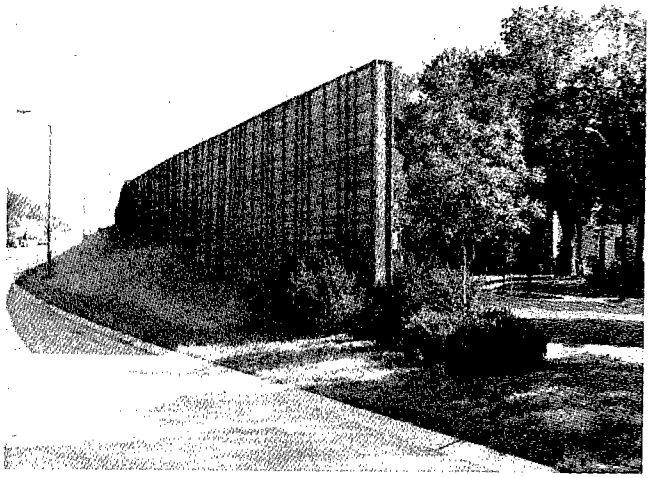
Equal spacing causes monotony. Variation in spacing and arranging trees in groups would have been more effective.



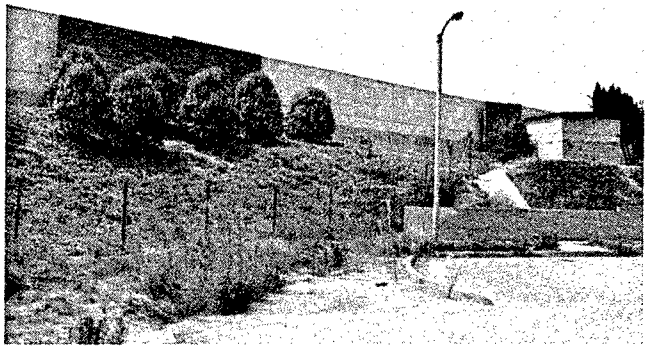
Hardly an adequate planting to reduce visual impact on the residential side of a barrier



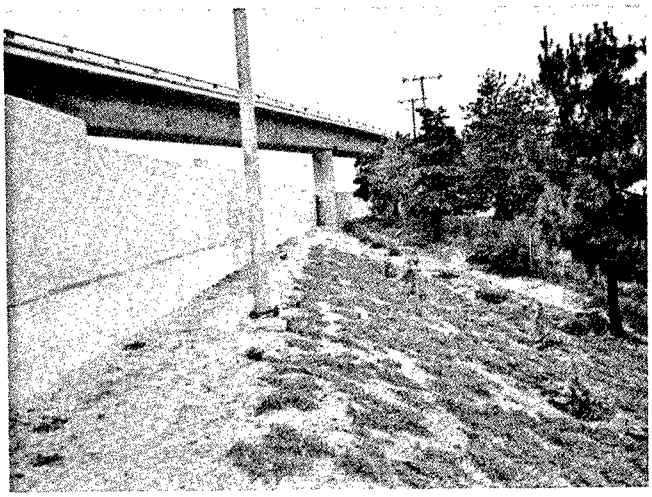
Too much repetition of similar shapes. A variation in plant materials would have been more effective visually.



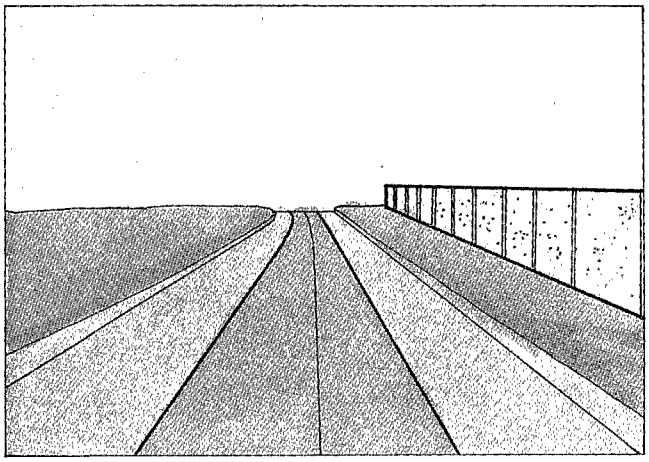
Plantings will eventually help to hide these walls and reduce visual awareness of the walls.



The view from the residential side of a barrier

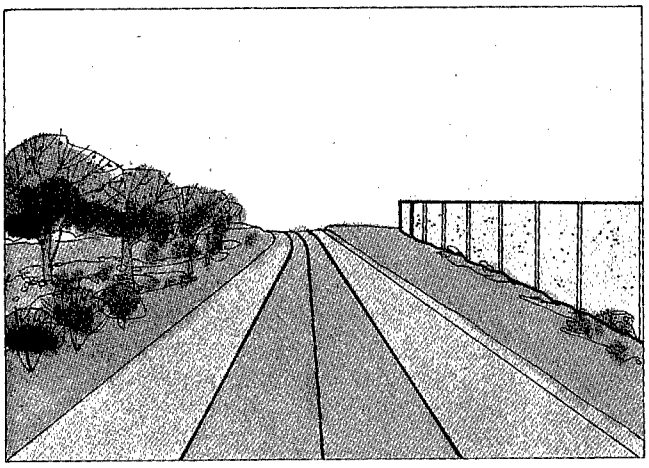


Shrubs or vines next to the wall would help to reduce the "barren" look here.

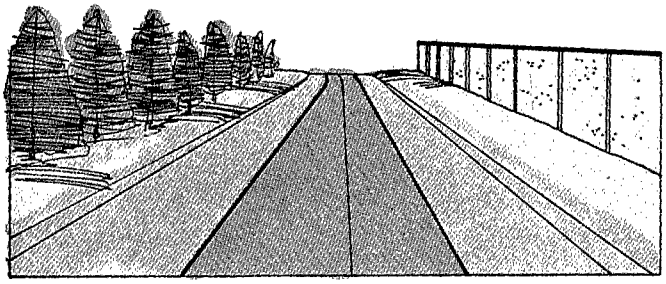


A long, high wall on one side of a highway axis creates a distracting visual imbalance. The eye is drawn to the wall and away from the road ahead.

The installation of plant materials against the wall and opposite the wall can effectively balance the axis in an asymmetrical manner. This tends to reinforce the axial view and directs the vision forward. The result is a decrease in visual dominance of the wall.

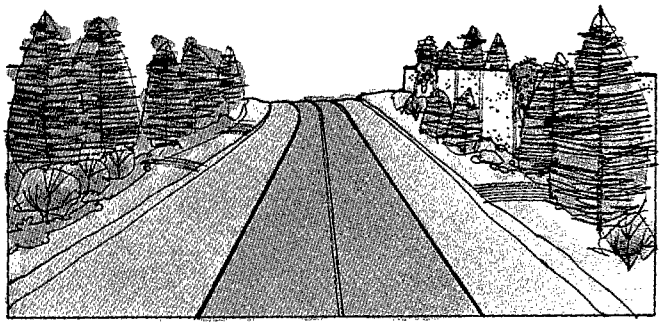


The designer should avoid creation of a monotonous symmetrical balance by the installation of a solid mass of equally spaced tree plantings.



An asymmetrical arrangement of tree plantings can effectively balance an axis and provide for visual interest as one moves through the composition. The variation in shapes, heights, and spacing creates a pleasant, changing experience for the moving viewer.

Plant masses should vary in height, color, and texture to add visual interest to a barrier. Year round color interest can be achieved through planting combinations of plant materials which bloom at different times of the year. Plants with colored foliage, vivid fall coloration, or colored bark and twigs may provide color interest in a changing display throughout the year.



Summary

In highway noise abatement, the main requirement is a solid, acoustically opaque barrier which is relatively durable. Many of the barrier walls in existence today have been constructed with elaborate detail, using expensive materials. In many cases, even these barriers lack visual quality or aesthetic appeal. A better solution might be to utilize less costly but durable materials, such as concrete, and achieve a visually attractive noise barrier through a combination of wall design and plant materials. The savings gained in material costs could offset the additional costs of adequate planting, with far better visual appeal and acceptance by the public.

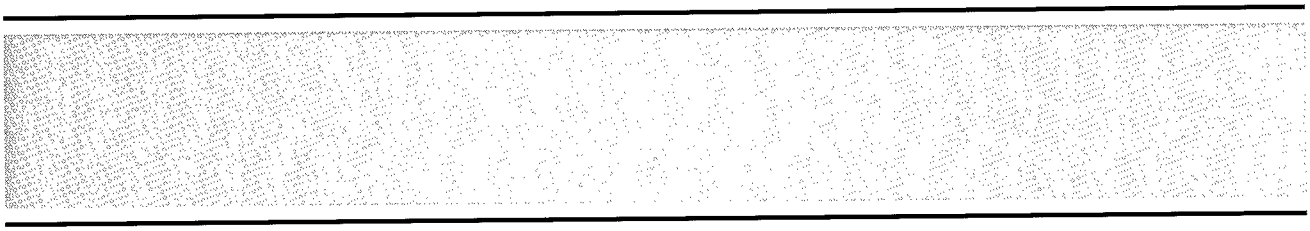
The added cost of visual quality in a design is often the subject of discussion among highway planners, administrators and citizens. This is often due to the misconception that visual quality in design means the substitution of highly expensive materials for more economical, widely available materials like concrete or concrete block. While it is true that a number of textural walls illustrated in this manual would indeed cost more to construct than a plain concrete wall, a visually attractive wall can be built without excessive additional expense. The principles covered in this manual, such as line, form, color and texture, can be applied using *any* material, with minimum additional cost. Due to the speed of the moving observer, wall materials used on the highway side of a barrier are less important than overall line, form and color, and the relationship of the barrier to other elements in the landscape. Such an observer sees a barrier as a mass in the overall highway scene, without regard for subtle details. On the residential side of a barrier, attention to detail may be more important, but a visually attractive barrier can be achieved using concrete that is accented with vines and other plant materials. The use of the most expensive materials in the construction of a noise barrier does not guarantee visual quality. Visual quality must be a product of the design process, and basic principles such as those contained within this manual must be used.

Epilogue

". . . The quality of the total landscape . . . is dependent upon the balanced relations which are achieved between the structural developments of man and the rock, earth, water, and plant forms of nature. While most city fathers and officials, owners, planners, architects, designers, developers, bankers, and builders will accept this thesis in general, few will fight for it in specific practice. All too easily, with polite regrets, they eliminate the saving, natural, "landscaping" elements—2 to 20 percent of the budget—in the interests of "economy," "functionalism," "practicality," "maintenance," "higher and better use of the land," and at times even "urbanism" or "architecture." They forget, or never learn, that this small fraction of the total budget, properly spent, may well account for 50 percent of the ultimate visual aspect ten years hence."

—Garrett Eckbo
The Landscaping We See

Appendix



Choosing Plants

Plants that are to be used along the roadside must be chosen with care, particularly with respect to the type of environment into which they will be placed. The highway environment presents a number of adverse situations that must be tolerated by the plants in order to survive. One condition that has been identified in recent years is often hazardous to both plants and man. That condition is *air pollution.* A major cause of air pollution today is the internal combustion engine used by millions of people in vehicles along our highways. Hazardous conditions are most likely to occur in dense, urban situations, and under atmospheric conditions which prevent or hinder air movement. Some plants are sensitive to this condition; others tolerate it. In urban situations where air pollution is likely to be a problem, plants which are resistant should be chosen.

Drought is another problem which is likely to occur along highways. In areas where annual rainfall is low, it is near impossible to maintain plantings without artificial irrigation. The costs for this are high; however, the benefit gained is often worth the price.

When properly used in a noise abatement system, plantings serve a distinct and necessary function. Since plantings contribute to the visual quality of noise barriers, proper steps to ensure their survival should be taken as part of the planning process. Drought resistant plantings should be used in arid regions; however, often even these will have difficulty in surviving along the highway, particularly for the first few years after planting. Some type of irrigation to augment natural rainfall should be included as part of the noise abatement project.

The use of a thick layer of mulch, such as wood chips, has proven to be a valuable aid to survival of plantings. A mulch will hold moisture, but also acts as an insulator, which helps to reduce evaporation losses resulting from the soil temperature on hot days. Mulches have the added advantage of inhibiting the growth of weeds, which compete with plantings for available moisture.

Plants that are relatively resistant to *disease and pests* are more likely to survive along the highway without requiring additional maintenance. Most highway plantings are likely to receive a minimum of maintenance, in the form of pruning, weed control, or preventative pest control. For this reason, native plants which are disease and pest resistant should be chosen for highway use, since they are more likely to thrive under low maintenance.

In northern areas of the country which have severe winters, plants along the highway are subject to damage by *salt* used on the roads. Some plants, particularly evergreens, are very susceptible to excessive salts in the soil. Other plants tolerate this condition fairly well. The designer should consider the possibility of salt damage to plants where this is utilized on the roads and confine the use of evergreens and other susceptible plants to areas that are not likely to receive water runoff from the highway. Salt spray from vehicles is also a problem which requires that susceptible plants be located at a sufficient distance from the pavement. Salt tolerant plants should be used wherever possible to minimize damage or plant loss.

There are a number of sources which are of use to the designer in choosing plant materials suitable for the highway environment. The following list is intended as a basic guide which should be augmented with locally available information. This may be available through state agricultural extension offices or state university horticultural departments, which should be able to make recommendations as to plant materials native to the area. In addition, most highway departments employ horticulturists who are familiar with plant species for the local hardiness zone and with highway planting requirements. For further information:

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Noise Absorption by Highway Noise Barriers

The current theories of highway noise abatement advocate the use of solid barriers which are reflective, in that they redirect a sound wave which strikes the surface of the barrier. In many situations, this type of noise abatement is acceptable. However, in certain situations, this may result in an unwanted reflection of noise, with a corresponding increase in noise on the opposite side of the roadway. Considerable research has been undertaken in recent years in order to develop noise absorbing barriers. Absorptive barriers have been tested and are in use along highways in Europe and appear to be beneficial in reducing noise levels, particularly in dense urban situations. Noise reflection by tall buildings adjacent to the roadway often results in higher noise levels within the right of way and between the roadway and adjacent buildings. In similar urban situations, consideration should be given to the use of absorptive material for barriers.

The highway environment prohibits the use of a wide variety of noise absorptive materials which are used indoors, in protected situations. Rain, ice, snow, dust, dirt, and temperature extremes combine to reduce the effectiveness of the absorptive material, or hasten deterioration, which makes these materials economically unfeasible for highway use. Research undertaken as part of this study has identified several materials and potential designs which may have an application for highway noise abatement and are presented herein for information purposes. The proposed designs require additional study, including the construction and testing of prototypes, in order to determine the performance and feasibility of these designs.

Noise Absorptive Materials Which are Currently Available

"STARKUSTIC", product of Stark Ceramics, Inc., Canton, Ohio 44711

"STARKUSTIC" ceramic is a structural tile that employs a glazed, perforated face on one side. The tile is hollow and four inches in thickness. The horizontal core is filled with a fiberglass pad which is vermin resistant, chemically inert, and steam cleanable. Moisture drains through the perforations.

The glazed ceramic surface of STARKUSTIC tile resists oils, grease, and other stains. Colors are fired in and will not fade—minimum maintenance is required. The tile and absorbent lining will not support combustion. Both a smooth face and a textured face are available. The tile is available in 5" x 12" and 8" x 16" face sizes.

"SOUNDBLOX", product of the Proudfoot Company, Inc., Post Office Box 9, Greenwich, Connecticut 06830

"SOUNDBLOX" are structural masonry blocks which employ vertical slots in one face of the block; the slots open to a cavity similar to other concrete blocks. The hollow chamber acts as a resonator to absorb noise. The cavities contain a fibrous filler or metal septa; the latter acts as an additional resonator. The blocks can be manufactured locally by approved concrete block manufacturers and are installed in a similar manner to other concrete block masonry walls.

"SOUNDBLOX" have been installed in outdoor situations, primarily to reduce noise from electrical transformers, and have proven to be efficient in reducing noise levels below that which could be expected with conventional masonry blocks.

"BROAD BAND SOUND ABSORBER" (NFA-1) developed by Lord Corporation/Allforce Acoustics, 3016 West Lake Road, Erie, Pennsylvania 16512

NFA-1 is a non-fibrous absorber designed to absorb sound by virtue of its geometry rather than the nature of the material from which it is constructed. It is similar to a Helmholtz resonator, in that it employs a triangular, hollow chamber, which traps the noise. However, this chamber contains an array of cells which vary in depth in a honeycomb arrangement. The variety in cell depth accounts for the broad range of frequencies that can be absorbed.

The chamber can be manufactured from a variety of materials, including aluminum, resin impregnated fiberglass, and impregnated paper. At this writing, Lord Corporation is actively engaged in the development and testing of additional materials from which to manufacture this product. Advantages of this type of sound absorber are that it potentially can be applied in outdoor environments, there is no fibrous filling to clog or deteriorate, and the cells can be readily cleaned by steam or high pressure water.

"NOISHIELD" product of Industrial Acoustics Company, Bronx, New York 10462

"NOISHIELD" is a modular absorptive barrier constructed of galvanized sheet metal. It employs a fiberglass filling that is protected by a perforated or porous material on one side and a solid, impervious surface on the other. "NOISHIELD" modules are also available in Cor-Ten Steel. The absorptive materials are claimed to be mildew and vermin proof and resist oil, dust, and water. The modules are four feet by twelve feet and are four inches thick. "NOISHIELD" barriers of this type are currently in use in railroad switchyards, and their performance in the outdoor environment can be readily assessed.

"PERMA-DELTA SOUND BARRIER" product of Permapost Products Company, P.O. Box 121, 25600 S.W. Tualatin Valley Highway, Hillsboro, Oregon 97123

The Perma-Delta Sound Barrier consists of a series of vertical, triangular shaped chambers which are similar to Helmholtz resonators in design. The chambers are constructed of treated plywood and are mounted upon a backing panel of plywood which serves as support and additionally as a noise attenuation surface. Sound waves are admitted to the interior of the chambers through narrow slots between chambers. The barrier is constructed in modular form. Each modular panel can be supplied in 2' x 4' or 4' x 8' sections. The manufacturer claims up to 13 decibels in noise reduction can be achieved with this product. Initial testing was completed by Oregon State Highway Acoustics Division; further testing of this product in a highway situation is recommended.

"COUSTIVIEW" product of Ferro Corporation, Composites Division, 34 Smith Street, Norwalk, Connecticut 06852

"COUSTIVIEW" is a transparent noise barrier material constructed from PVC, which is claimed to be resistant to yellowing, fading, and clouding. The material is a limp sheet of transparent film which must be supported in a framework of some type. PVC is normally used in manufacturing industries for visual monitoring of machinery, while providing some degree of noise protection. There are many situations where a transparent highway noise barrier would be advantageous, particularly where required sight distances would be adversely affected by a solid barrier. This material should be tested under outdoor environmental conditions in order to determine its ability to withstand temperature extremes, etc. "COUSTIVIEW" is available in 48 inch by 20 yard rolls in 0.04" or 0.08" thicknesses.

Manufacturers of Highway Noise Barriers

Armco Steel Corporation, Metal Products Division, Middletown, Ohio

Armco offers several types of steel noise barriers constructed of "steelox" structural panels. Panels to be used in horizontal applications are either flat or sculptured rib design and are mounted to exposed vertical steel posts with self-tapping screws. Vertical panels are available in a trapezoidal corrugated rib pattern, and are mounted to vertical steel posed vertical steel posts with self-tapping screws. Vertical panels may be applied as a double skin, or in an alternating pattern, to cover the exposed vertical supports. Steel corner flashings, top caps and end caps are available and recommended for use with a vertical panel wall.

Panels are available in nine colors of fluoropolymer enamel, which is resistant to weathering, salts, and stains.

For severe environments, an acrylic film coating is available which is further resistant to corrosion by salts used along the highway. Base metal is galvanized or may be specified with an aluminum coating for further resistance to deterioration.

Fanwall Sales Corporation, Box 868, Framingham, Massachusetts

Fanwall is a pre-cast concrete modular panel system which can be constructed in a variety of configurations. By assembling the panels at an angle to one another, an extremely stable wall which requires no footings can be constructed. Fanwall claims that noise barriers of this type can be constructed quickly and at a cost competitive with other barrier types. A variety of surface textures are available including exposed aggregate, striated, simulated wood, stone and brick. Fanwall has developed a transparent barrier of similar design using polycarbonate sheets in either a continuous or staggered arrangement. Standard colors available with cast concrete may be applied to any Fanwall panel during the casting process.

Maccaferri Gabions, Inc., Box 43A, Governor Lane Boulevard, Williamsport, Maryland 21795

Gabions supplied by Maccaferri are constructed of woven wire mesh which is available in a galvanized finish or galvanized with a black PVC coating. PVC coating is recommended in locations where extreme corrosion due to salts is likely. A variety of gabion sizes are available. The manufacturer recommends that free standing walls be constructed in a pyramid arrangement if wall height is to exceed 9 feet; otherwise gabions may be stacked directly upon one another to form a vertical wall. Rock fill to be used with gabions should be approximately 4" x 8" in diameter and preferably should be washed.

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